Vernier

Data-Collection Technology

Vernier International

CATALOGUE
2014

Chemistry, Physics, Biology, STEM, Biotechnology
Engineering, Math, K–8, Physical Science, Physiology
Environmental Science, Water Quality, Earth Science

HALL OF FAME
OREGON BUSINESS AWARD

2013 HEALTHIEST EMPLOYERS
2ND PLACE

PLACED 26TH OF 100
BEST GREEN COMPANIES
IN OREGON

PLACED 11TH OF 60
TOP WORK PLACES IN
OREGON

BUSINESS JOURNAL
CORPORATE PHILANTHROPY
AWARD FOR 2013

VERNIER IS PROUD TO BE RECOGNIZED FOR ITS PHILANTHROPIC COMMITMENT, ENVIRONMENTAL POLICIES, STEADY GROWTH, AND AS ONE OF THE BEST 100 COMPANIES TO WORK FOR IN OREGON FOR 13 YEARS IN A ROW.

Go Wireless with Vernier

LabQuest 2 has been a huge hit since its introduction in 2012. It was the first step in our Connected Science System, which continues to grow. This year we are introducing a product we could only dream about a few years ago—a temperature sensor that wirelessly transmits data—Go Wireless Temp.

Our other wireless options keep expanding (and will continue to do so). We now support data collection with the NODE line of wireless sensors from Variable, Inc., and we have introduced our first Android data-collection app, Graphical Analysis.

We are also introducing a number of new sensors, including a completely new method of monitoring the position of a cart on a dynamics track, a PAR Sensor for biology, and a Potassium Ion-Selective Electrode for chemistry. Even if you have an interface that is a dozen years old, you can still use these new sensors.

We are excited about two new spectrometers—a UV-VIS Spectrophotometer for chemistry and biology, and an Emissions Spectrometer for physics.

We are pleased to be partnering with KidWind to provide creative solutions for hands-on wind and solar energy experiments. Watch for new solutions and curriculum coming this year.

On a personal note from Dave Vernier, I have had a lot of fun working on sample code for using our sensors with inexpensive Arduino™ microprocessors. It is much like what I was doing 35 years ago on an Apple II computer, but much easier, faster, and less expensive. What a great way to introduce students to STEM subjects! Check out **www.vernier.com/arduino**

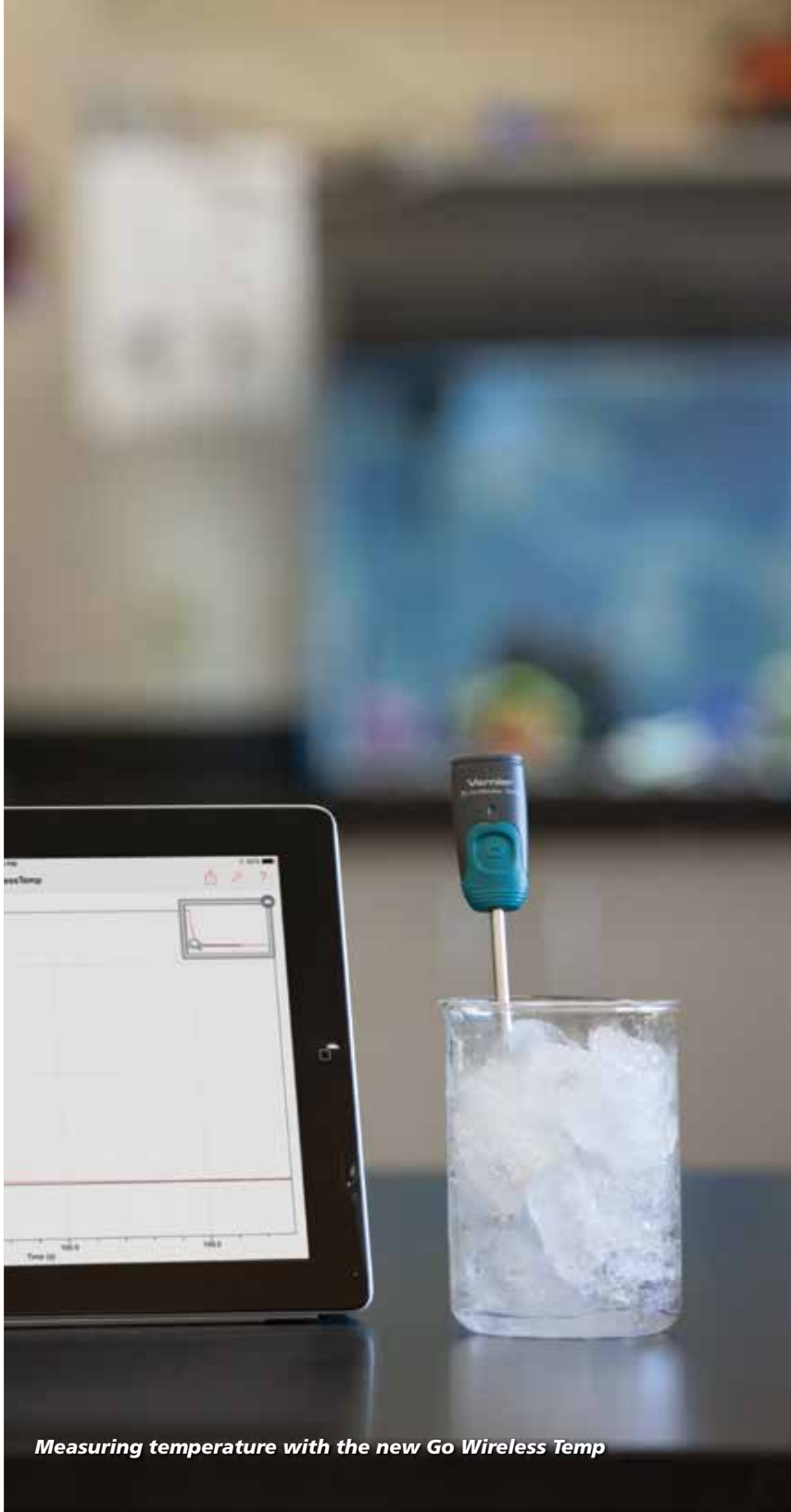
Even with all these new products and partnerships, some things stay the same. As always, we encourage you to give our products a try on a 30-day preview basis, and feel free to contact either of us personally at any time.

Dave and Christine Vernier
dvernier@vernier.com and cvernier@vernier.com

VERNIER SOFTWARE & TECHNOLOGY

Vernier Software & Technology was co-founded in 1981 by Dave and Christine Vernier. Dave's background as a physics teacher and Christine's knack for business combined to form a company with a deep commitment to education.

Thirty-three years later, the company is still owned by Christine and Dave, along with 11 employee owners who have backgrounds in science and math education, as well as business.



Measuring temperature with the new Go Wireless Temp

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What's NEW

Data Collection for Tablets and Mobile Devices

Check out the new solutions we've developed for iPad®, Android™ tablets, Chromebook™, and BYOD.

NEW TABLET-BASED DATA COLLECTION PAGES **4–9**

NEW WIRELESS SENSORS PAGES **6–7**

NEW PROSCOPE MICRO MOBILE PAGE **40**

APPS FOR TABLETS PAGE **5**

Graphical Analysis for iPad – Now you can view and analyze data with this native iOS app.

NEW Graphical Analysis for Android – Designed for Android tablets, you can use this app to collect and analyze data.

Video Physics – Perform video analysis on the iPad, iPhone®, and iPod touch®.

NEW Go Wireless app – Use this free iOS app to wirelessly collect, view, and analyze data from Go Wireless Temp probes.

NEW Go Wireless™ Temp

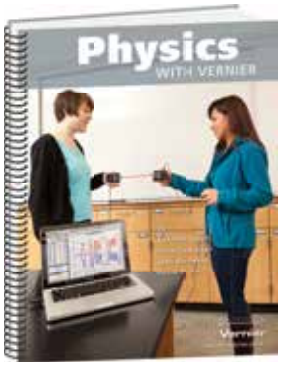
The Vernier Go Wireless Temp is a rugged, general-purpose, wireless temperature sensor you can use to remotely monitor temperature. Great for use with iPad!

PAGE **6**

NEW NODE+ from Variable, Inc.

NODE+ is a wireless sensor platform controlled by a mobile device, such as an iPad, that allows students to explore concepts in topics such as Earth science, environmental science, and physical science. Sensor modules are available to measure temperature, light, relative humidity, and more.

PAGE **7**



UPDATED *Physics with Vernier* Lab Book

Check out the new edition of *Physics with Vernier*. Enhanced experiments feature time estimates, more instructor tips, and improved Preliminary Questions to get students thinking. We also incorporated more Vernier equipment, including the Vernier Projectile Launcher and the Optics Expansion Kit.

PAGE **84**

NEW Vernier UV-VIS Spectrophotometer

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer. It is an easy-to-use, accurate instrument, ideal for measuring the absorbance spectra of various chemical and biochemical compounds. As a USB device, it plugs directly into your computer or LabQuest.

PAGE **51**

NEW Potassium Ion-Selective Electrode

The Potassium Ion-Selective Electrode can be used to measure the concentration of potassium (K^+) ions in aqueous solutions. This electrode can be used for testing in the field and in circumstances where other means of measuring potassium ions is cumbersome or prohibitively expensive.

PAGE **134**

NEW PAR Sensor

The PAR (Photosynthetically Active Radiation) Sensor measures photosynthetic light levels in both air and water. It features a waterproof sensor head and can be used to measure Photosynthetic Photon Flux Density (PPFD) from sunlight and electric light sources. It is sensitive to visible light in the spectral range that is used by plants in photosynthesis (400–700 nm).

PAGE **137**

NEW Vernier Motion Encoder System

The Motion Encoder System is a revolutionary way for physics students to study dynamics. Optical position measurement eliminates setup frustration, keeping the focus on the physics.

PAGES **96–97**

NEW Vernier Emissions Spectrometer

Use the Vernier Emissions Spectrometer to instantly collect emissions spectra from light bulbs, gas discharge tubes, or the sun. Capture data and analyze it immediately on your computer or LabQuest.

PAGE **142**

NEW KidWind Experiment Kits

KidWind and Vernier offer a perfect solution for data collection for renewable energy and the Science and Engineering Practices for the Next Generation Science Standards.

PAGE **71**

Which Tablet Solution is Best for Me?

LabQuest 2 and the Connected Science System®

Full Support for Vernier Sensors

LabQuest 2

If you are looking for maximum flexibility for sensor-based data collection or if your school already owns a variety of Vernier sensors, LabQuest 2 is your best option for tablets. In addition to connecting with tablets, you can use LabQuest 2 as a standalone device or connected to a computer. See page 11–16 or **www.vernier.com/labquest**

OR

Wireless Sensors

Connect Wirelessly to Your Tablet Without an Interface

Go Wireless Temp

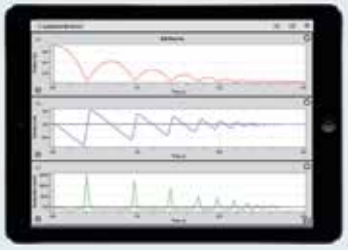
Developed by Vernier, this stainless-steel temperature probe is the first in a series of wireless sensors that communicates directly with your tablet. It's completely wireless, affordable, and backed by Vernier's legendary support. See page 6 or **www.vernier.com/gw-temp**

NODE+

NODE is a handheld, wireless sensor platform developed by Variable, Inc., and is supported by Vernier for use in education. Using this compact device, you can stream data to your tablet using a variety of interchangeable sensing modules. See page 7 or **www.vernier.com/node**

Vernier Supports iPad, Chromebook, Android, and BYOD

iPAD



iPad with Graphical Analysis

GRAPHICAL ANALYSIS FOR iPad

Designed specifically for iPad, Graphical Analysis makes it easy for students to wirelessly collect, analyze, and share sensor data from a Data Sharing source, such as LabQuest 2 or Logger *Pro*. See page 9 or **www.vernier.com/ga-ipad**

iPad with Video Physics

VIDEO PHYSICS

Video Physics brings powerful video capture and analysis to iPad, iPhone, and iPod touch. See page 26 or **www.vernier.com/video-physics**

iPad with LabQuest Viewer

LABQUEST VIEWER

Teach students how to use LabQuest by projecting your LabQuest screen via Wi-Fi. Use built-in Wi-Fi on LabQuest 2 to remotely monitor student progress by viewing student LabQuests. See page 26 or **www.vernier.com/lq-view**

iPad Mini with ProScope Micro Mobile

PROSCOPE MICRO MOBILE

Turn your tablet into a microscope. ProScope Micro Mobile is the first professional-level microscope for use with mobile devices in science education. Models are available for iPhone/iPod touch, iPad, and iPad mini. See page 40 or **www.vernier.com/bd-pmm**

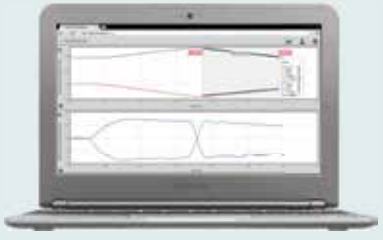
ANDROID

Nexus™ 7 with Graphical Analysis

NEW GRAPHICAL ANALYSIS FOR ANDROID

Designed specifically for Android tablets, this app provides a fluid, intuitive, and personal experience as individual students collect and share data. Graphical Analysis for Android will be available for purchase via Google Play this spring, and a time-limited, free preview is available immediately. See page 9 or **www.vernier.com/ga-android**

CHROMEBOOK AND BYOD



Chromebook with Data Share web app

VERNIER DATA SHARE WEB APP

Ideal for a bring-your-own-device environment, Vernier Data Share supports iPad, iPhone, iPod touch, Android phones and tablets, Chromebooks, notebook computers, and more. Students can use various compatible devices to collect, graph, and analyze data. See page 9 or **www.vernier.com/data-share**

Go Wireless™ Temp

ORDER CODE
GW-TEMP

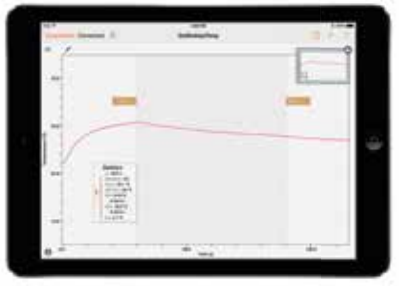
NEW Wireless Temperature Probe for iOS Devices

Vernier Go Wireless Temp is a rugged, general-purpose, wireless temperature sensor that you can use just like a thermometer. Its durability, temperature range, and wireless capability make it perfect for a variety of uses.

This sensor communicates with host devices such as iPad (3rd generation or newer), iPad mini, iPod touch (5th generation), or iPhone 4S or newer.

Android support for compatible hardware available later this year.

Free Go Wireless app



Full-featured Graphical Analysis for iPad

Available on the App Store

Download Graphical Analysis for iPad or the free Go Wireless app

EXPERIMENTS

Vernier Go Wireless Temp is watertight and accurate. It can be used inside or outside, rain or shine—wherever your experiments take you. Experiment possibilities include

- Science fair projects
- Monitoring environmental conditions
- Monitoring the temperature in a fish tank or greenhouse
- Measuring the efficiency of a Thermos™
- Measuring the temperature of the air coming from an air conditioner or furnace

PRODUCT SPECIFICATIONS

Temperature range: –40 to 125°C
Resolution: 0.07°C
Accuracy: ±0.5°C

WHAT'S INCLUDED

Sensor includes a USB charging cable*, a quick-start guide, the free Go Wireless app (available on the App Store), and an online user manual.

Go Wireless Temp is also compatible with Graphical Analysis for iPad (separate purchase required).

* Go Wireless Temp can be charged by connecting the included charge cable to a computer USB port or USB wall adapter (not included).

GO WIRELESS CHARGING STATION

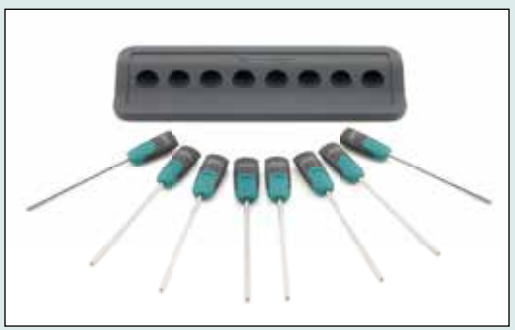
ORDER CODE **GW-CRG**

The Go Wireless Charging Station is the perfect solution for charging and storing your Go Wireless Temp probes. Each charging station has eight charging slots. LED lights on the Go Wireless Temp probes indicate charging.

GO WIRELESS TEMP TEACHER PACK

ORDER CODE **GW-TEMP-TP**

The Teacher Pack includes eight Go Wireless Temp probes and a Go Wireless Charging Station.



Investigating freezing point depression with Go Wireless Temp

Simple harmonic motion with the NODE+ Sensor Platform

NODE+ from Variable, Inc.

NODE+ is a wireless sensor platform that is controlled by a mobile device, such as an iPad. Students can explore topics in Earth, environmental, and physical sciences. The NODE+ Sensor Platform includes a 3-axis gyroscope, accelerometer, and magnetometer. Also included are two expansion ports where additional NODE+ sensor modules, such as the two described below, can be attached.

CLIMA Module

CLIMA measures humidity, temperature, light level, and barometric pressure.

THERMA Module

THERMA is an infrared temperature sensor that measures surface temperature from a distance up to 15 feet.

For more information, including software support, prices, sample experiments, and other available modules, visit **www.vernier.com/node**

LABQUEST® 2
CONNECTED SCIENCE SYSTEM®

How it Works

1. Students in a lab group set up an experiment with Vernier sensors and LabQuest 2.
2. Students use a Data Sharing app to wirelessly start data collection.
3. Experiment data is streamed from LabQuest 2 to each student's Data Sharing app.
4. Each lab group member performs an individual analysis on their Data Sharing app.
5. Students take their data and analysis home with the Data Sharing app for further analysis and use in a lab report.

TEACHERS

- Use a robust data-collection system that is compatible with tablet-based and bring-your-own-device (BYOD) classrooms
- Have the flexibility to use LabQuest 2 with iPad, Android, Chromebook, and other mobile devices, as well as to use it as a standalone device or with computers
- Are supported by Vernier's extensive video library
- Have access to Vernier's world-class technical support, which includes both former science teachers and technology experts
- Benefit from dozens of standards-aligned lab books, which include teacher notes, safety precautions, and detailed technology instructions

STUDENTS

- Wirelessly collect scientific data using a variety of sensors and digital tools
- Analyze an individual copy of collected data
- Annotate data, perform curve fits, and make statistical calculations to build evidence of personal understanding
- Tap, drag, pinch, and stretch graphs in an immersive, multi-touch environment
- Create a lab report or submit data to the teacher via email, camera roll, print function, and even third-party apps for notes and reports

What You Need

1. DATA SHARING SOURCE

LabQuest 2 Interface

The wireless capabilities of LabQuest 2 allow lab groups to stream sensor data on your school or lab network.

- Compatible with all Vernier sensors
- Supports multiple sensors simultaneously
- Built-in sensors including GPS and accelerometers
- Simultaneously stream data to multiple Data Sharing apps (via Wi-Fi)

OR

Computer

For data sharing with a computer, go to **www.vernier.com/data-sharing/sources/**

2. SENSORS

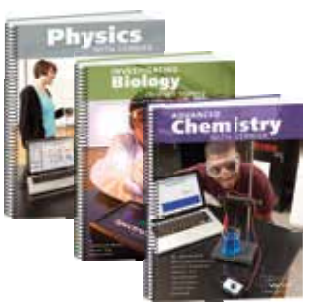
Choose from over 80 compatible sensors for Chemistry, Biology, Physics, STEM, Math, K–8, Water Quality, Physiology, Physical Science, Environmental Science, and Earth Science.
See pp. 126–147

3. LAB BOOKS

Vernier lab books are loaded with teacher tips, sample graphs, and more. Each book includes

- Essential teacher information
- Ready-to-use student versions
- A generous site license (Buy one book and duplicate experiments for your class.)
- Editable student pages (Microsoft® Word® files for all student pages are provided on CD.)
- Suggested answers, sample data, and graphs

See pp. 108–115



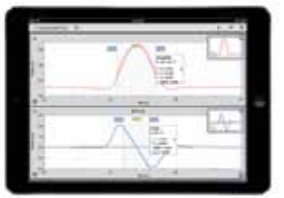
4. DATA SHARING APPS

iPad and Android

Graphical Analysis™ App

With Graphical Analysis, teachers and students can

- Automatically detect Data Sharing sources on the network
- Simultaneously connect multiple devices to the same Data Sharing source
- Collect data from built-in accelerometers
- Individually analyze and annotate data
- Auto-save work
- Export graphs or data to other apps
- Send graphs or data to the teacher



Available on the App Store

ANDROID APP ON Google play

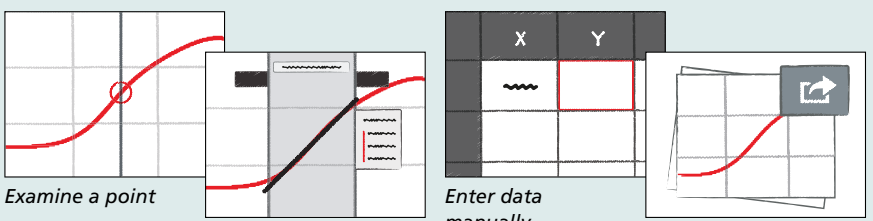
AND/OR

Chromebook and BYOD

Vernier Data Share™ Web App

With Vernier Data Share, teachers and students can

- Simultaneously connect multiple devices to the same Data Sharing source
- Perform data collection and analysis in the browser with no store download required
- Individually analyze and annotate data
- Work on the most recent experiment in offline mode
- Save graphs and data to the device for use in other apps, email, or printing



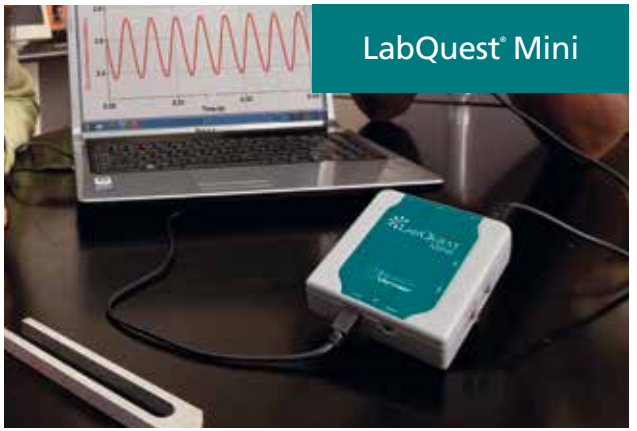
Examine a point

Select a range, annotate, and apply fits

Enter data manually

Export graphs and data

INTERFACE CHOICES



INTERFACES—COMPATIBILITY / PRICE CHART

CHOICES		SUPPORTED PLATFORMS	MAXIMUM SAMPLING RATE	COMPATIBLE VERNIER SENSORS	REMOTE DATA COLLECTION	BUILT-IN COLOR SCREEN	RECHARGEABLE BATTERY	BUILT-IN SENSORS	SUPPORTS MULTIPLE SENSORS	SOFTWARE	STANDARDS-BASED LABS
LabQuest® 2 ORDER CODE **LABQ2** See pp. 11–16		Standalone Computers Tablets Mobile Devices	100,000 per second	84 sensors See page 16 for a compatible sensor list	Built in	Yes	Yes	Temperature Microphone GPS Accelerometers Light	Yes	Built-in LabQuest and other applications See pp. 13–15 Logger Lite (free download) Logger *Pro* (sold separately) See pp. 22–25	100 included labs 300+ more available on web site 400+ labs available in print See page 114
LabQuest® Mini ORDER CODE **LQ-MINI** See pp. 18–19		Computers	100,000 per second	71* sensors See page 19 for a compatible sensor list	With a laptop computer	No	No batteries needed (USB powered)	None	Yes	Logger Lite (free download) Logger *Pro* (sold separately) See pp. 22–25	300+ more available on web site 400+ labs available in print
Go!Link® ORDER CODE **GO-LINK** See page 20		Computers	200 per second	56* sensors See page 20 for a compatible sensor list	With a laptop computer	No	No batteries needed (USB powered)	None	No	Logger Lite (included) Logger *Pro* (sold separately) See pp. 22–25	300+ more available on web site 400+ labs available in print

* Count does not include 12 USB or Bluetooth® sensors that connect directly to the computer and can be used in a computer-based lab station.

FOR TI CALCULATOR-BASED DATA COLLECTION: see pp. 116–123

Meet LabQuest® 2

The most powerful, connected, and versatile data-collection device available for STEM education

AWARD-WINNING TECHNOLOGY

Worlddidac Award granted to both LabQuest 2 and the Connected Science System

Readers' Choice Award from eSchool Media awarded to LabQuest 2

Codie Award Finalist presented to the LabQuest 2 app

READ THE REVIEWS

Tech & Learning – "Vernier's LabQuest 2 can build interest in science, make experiments come alive, and deepen understanding of complex concepts. The affordable handheld tool supports student-centered, inquiry-based learning...and critical analysis as budding scientists use real tools to conduct real-time investigations...." – Carol S. Holzberg, Ph.D.

Assistive Technology – "With the LabQuest 2, Vernier has transformed the way teachers need to think about teaching science in the classroom and provided them with an easy and powerful solution for capturing data in real time." – Brian Friedlander, Ph.D.

Scholastic Administrator's Tech Tools – Grade: A, "A bargain. LabQuest is a modern-day science lab that fits in the palm of a hand." – Brian Nadel

NSTA Blog – "It seemed obvious that the LabQuest 2 would be a real game changer in the data-collection space, but after our field test, it seems more that the LabQuest 2 has invented an entirely new game." – Martin Horejsi

Read the full reviews of LabQuest 2 and the Connected Science System at **www.vernier.com/labquest**

LABQUEST® 2
CONNECTED SCIENCE SYSTEM®

ORDER CODE
LABQ2

Meet LabQuest 2

The most powerful, connected, and versatile interface ever

Presenting the most powerful interface for science education. Engage your students with hands-on science in your classroom or in the field.

Use it as a standalone device, as a wireless sensor interface for tablets and mobile devices, or as a computer interface with our award-winning Logger *Pro* or Logger Lite software. Created with today's classroom in mind, you will love its high-resolution screen, responsiveness, and ease of use. And, of course, because it was developed by Vernier, it is backed by comprehensive curricula, a generous warranty, and legendary support.

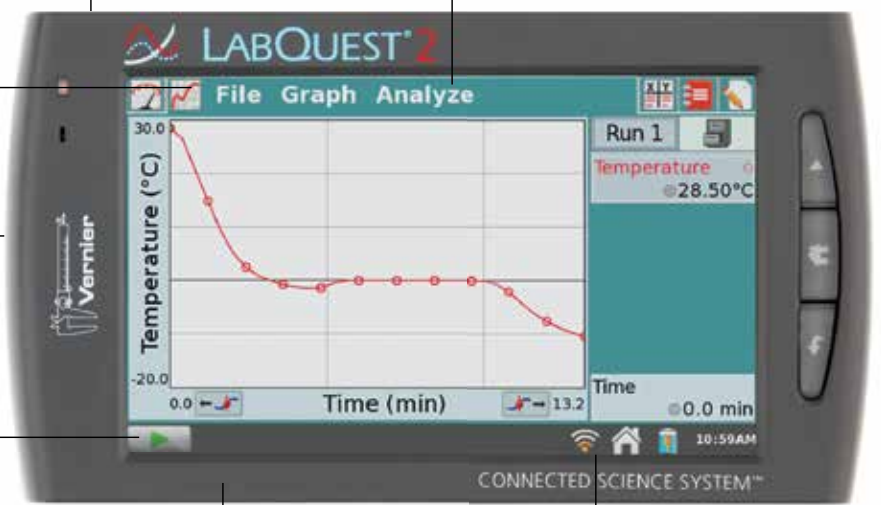
Full sensor support
Compatible with all Vernier sensors

Faster analysis
Quick response to touch, curve fits, and modeling

High-resolution touch screen
- 12.8 cm, 800 x 480 pixel resolution
- Designed for both stylus and touch
- Wide viewing angle for lab groups

Built-in sensors
- GPS
- 3-axis accelerometer
- Ambient temperature
- Light
- Microphone

Fast data collection
100,000 samples per second



Rechargeable battery
High capacity, lithium-ion rechargeable battery

Wireless connectivity
- Wi-Fi
- Bluetooth

2012-2013 Award Winner

worlddidac AWARD 2012

//CODiE// 2013 SIIA CODiE FINALIST

Included with LabQuest 2: LabQuest 2 unit, rechargeable battery, USB cable, power adapter, stylus, stylus tether

USB port for USB sensors, flash drive, or other USB peripherals.

Two digital sensor ports for use with motion detectors, photogates, drop counters, and more.

Three analog sensor ports for use with 60 compatible sensors, such as temperature, pH, and CO_2 sensors.

Power port – Use with AC or recharge LabQuest's built-in battery.

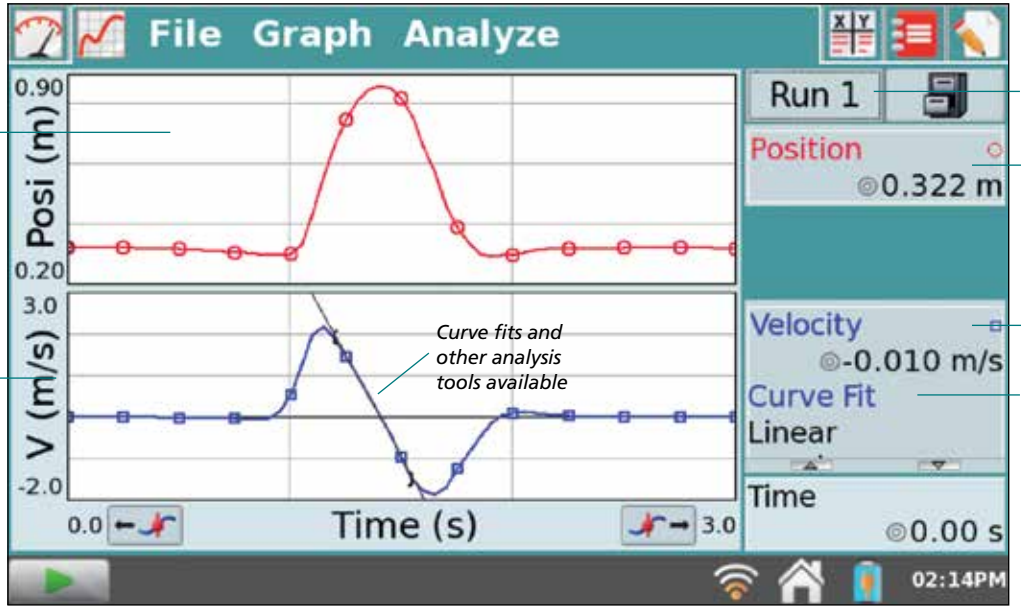
Micro SD/MMC card slot

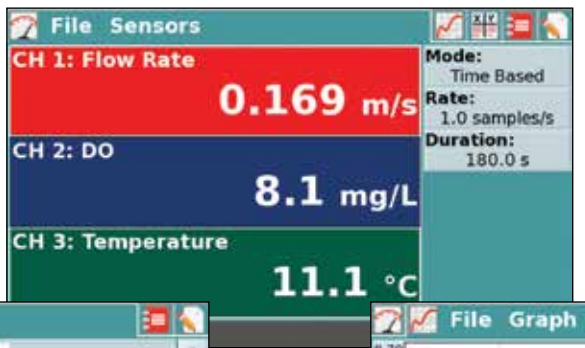
Computer Connectivity
Connect your LabQuest to a Windows or Macintosh computer to collect data using Logger *Pro* or Logger Lite.

Audio in (left)
Audio out (right)
Connect speakers, microphone, power amplifier, or headphones.

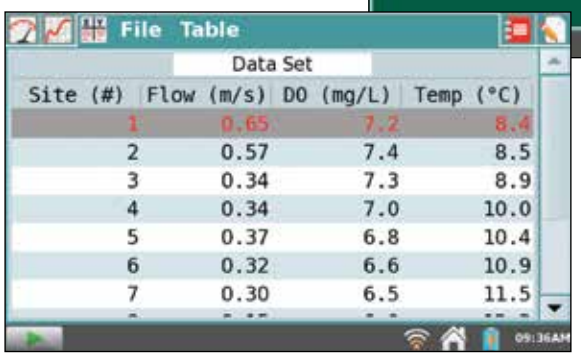
TECHNICAL SPECIFICATIONS

Screen Size: 11.2 cm × 6.7 cm
Screen Resolution: 800 x 480 color display
Weight: 350 g
CPU: 800 MHz application processor
Battery: Lithium-ion rechargeable battery; carries a one-year warranty

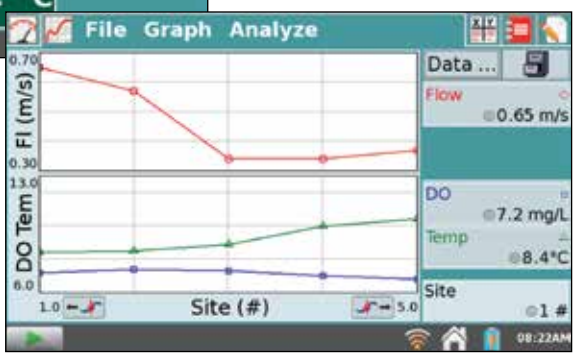




Meter



Data table



Graph

Built-In Software

ANALYSIS FEATURES

- Perform linear and curve fits
- Landscape and portrait views
- Supports built-in sensors—GPS, microphone, accelerometers, relative light sensor, temperature
- Draw a prediction before collecting data
- Display two graphs at once
- Display a tangent line on the graph
- Integral function
- Statistics

BUILT-IN APPLICATIONS

- Stopwatch
- Periodic table
- Scientific calculator
- Audio function generator
- Power amplifier (requires Vernier Power Amplifier)

OTHER GREAT FEATURES

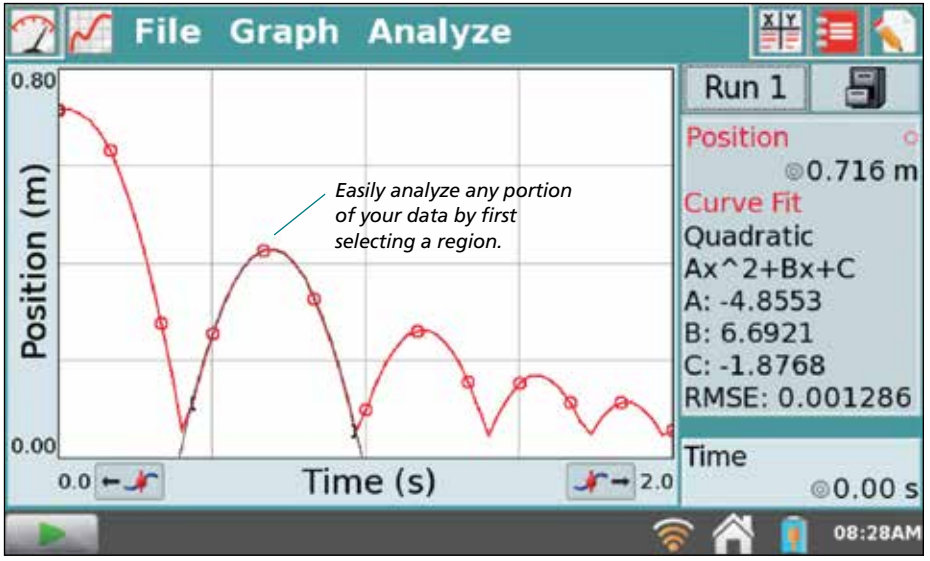
- Export data to Logger *Pro*
- View with our Logger Lite (free download from our web site)
- More than 100 preloaded lab instructions from Vernier's popular lab books
- Notes field
- Voice annotation with internal microphone
- Find slopes, fit a line to a portion of your data, and display position data and its derivatives

One-Touch Simplicity

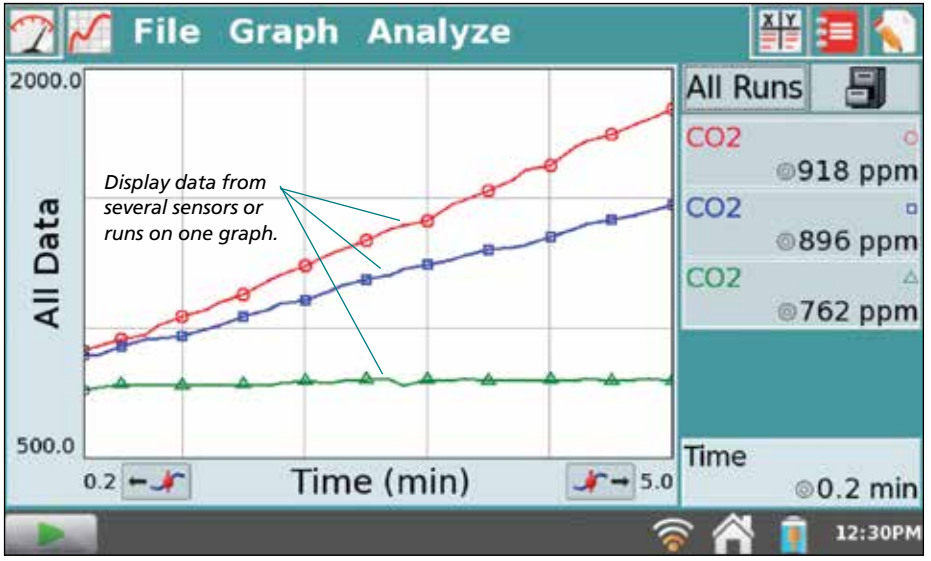
The LabQuest App gives your students real-time graphing capabilities in a handheld device. It's powerful—yet beautifully simple.

Your students can collect data and view them in a **Data Table, Meter,** or **Graph View.**

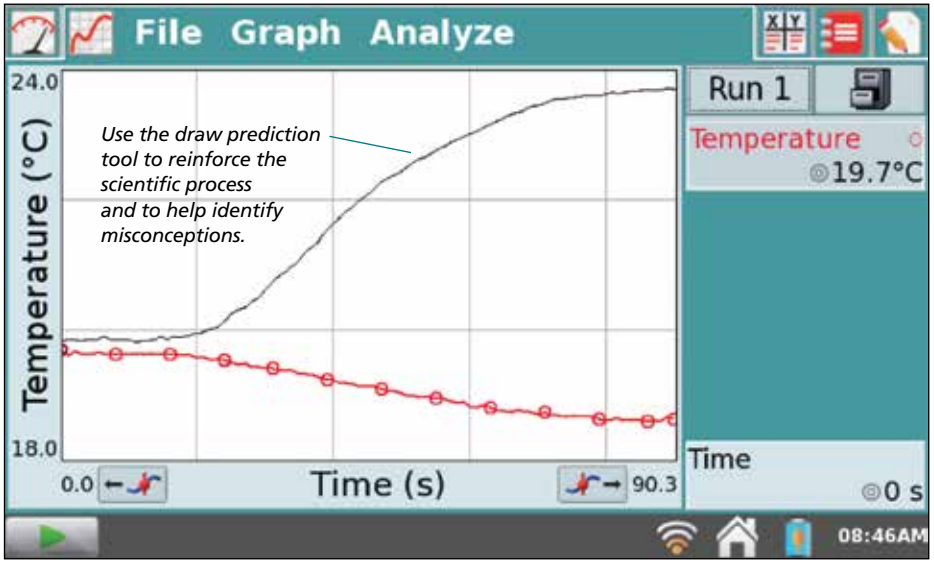
Data analysis at your fingertips



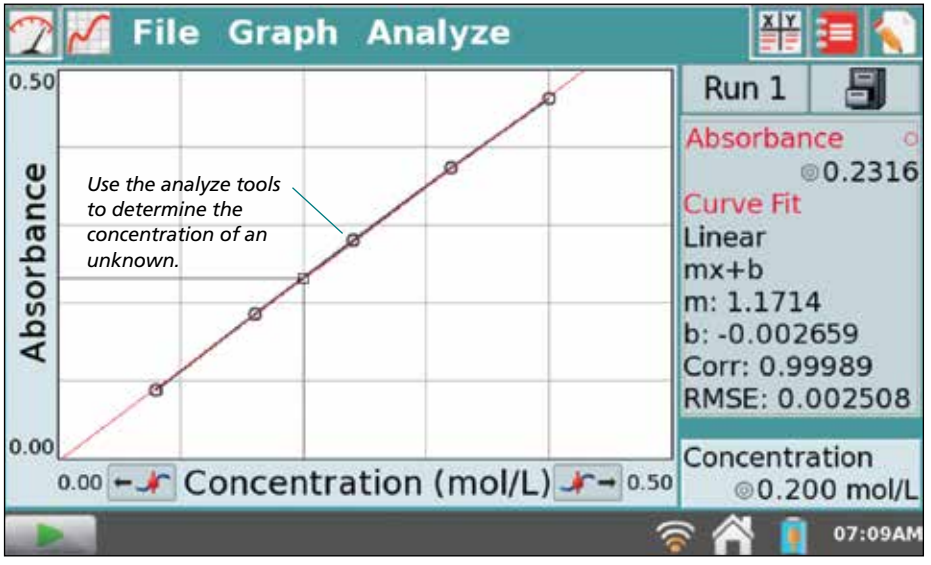
Position vs. time graph of a bouncing ball



Investigating the rate of cellular respiration at different temperatures

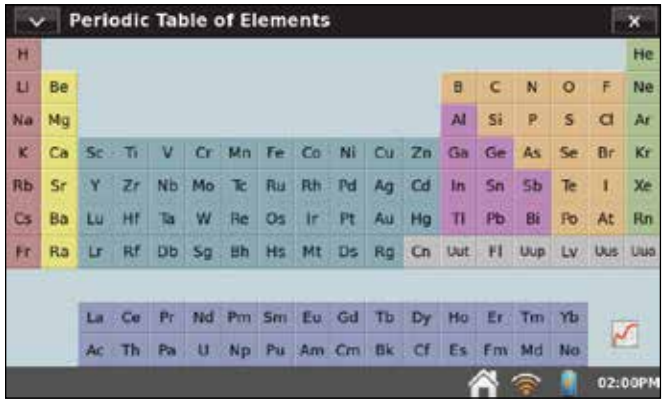


Temperature vs. time graph as an Alka-Seltzer® tablet dissolves in water

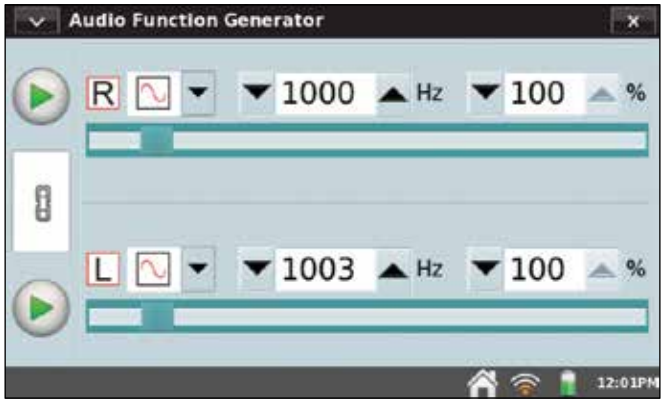


Beer's law analysis of nickel (II) sulfate solution

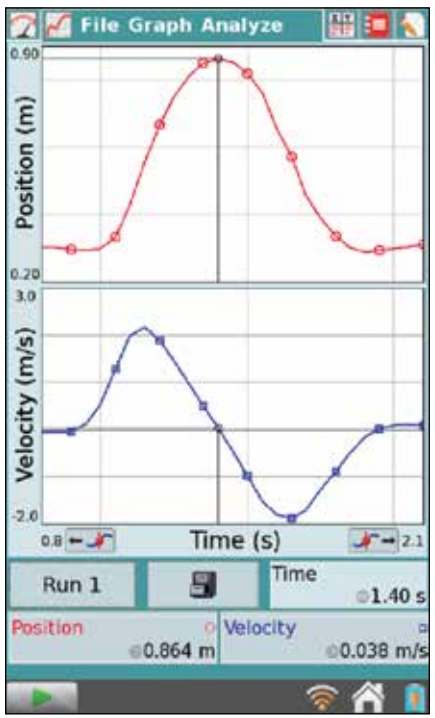
Additional applications and features



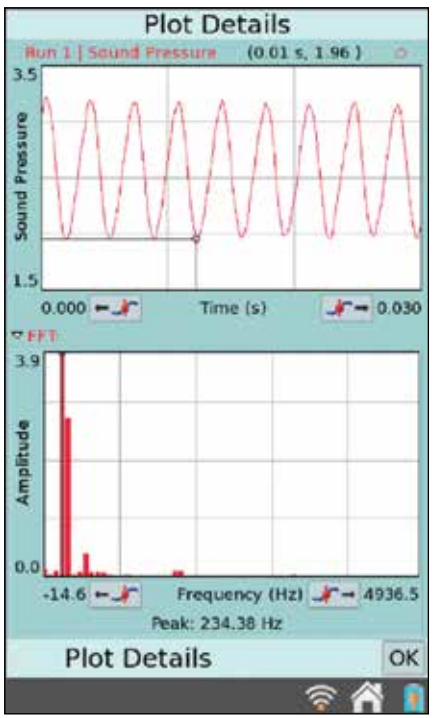
On-board Periodic Table Application



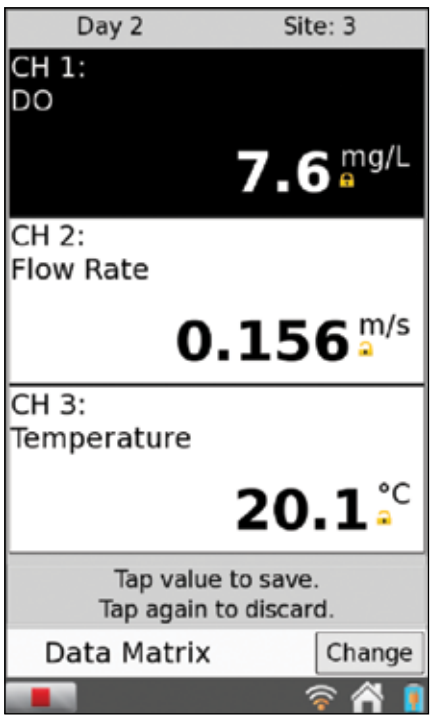
Audio Function Generator



Rotate your LabQuest 2 to view two graphs in portrait view.



Advanced analysis features include FFT analysis.



High-contrast screen setting makes it easier to see your data in bright light.

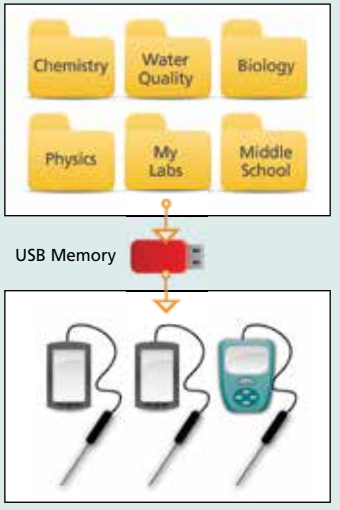
MY LABQUEST LIBRARY

My LabQuest Library allows you to create, customize, organize, and download labs to LabQuest for the entire class.
www.vernier.com/mylabquest

LAB CREATOR | LAB ORGANIZER

Create your own labs with the Lab Creator
Use this **FREE** custom application to create and easily upload your labs to LabQuest.

Customize your LabQuest with the Lab Organizer
More than 400 Vernier experiments from 16 lab books are available to upload to your LabQuest.

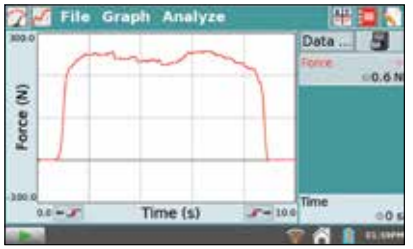


Did you know?

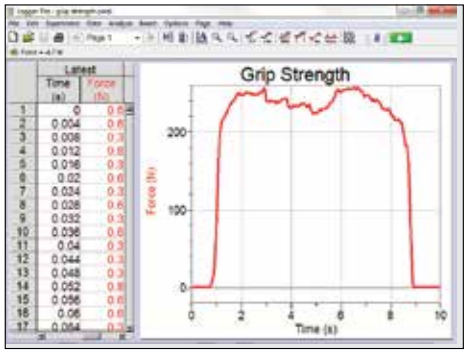
You can have a mixed classroom of LabQuest 2 and original LabQuest units without having to give separate lab instructions for each. We designed the LabQuest 2 to support side-by-side use with the original LabQuest. See page 114.

Easily download your data from LabQuest to a computer for further analysis with Logger *Pro* Software

For more information about Logger *Pro*, see pp. 22–25.



Determining grip strength



Screens are from LabQuest 2 (above) and Logger Pro *(right).*

LABQUEST 2 COMPATIBLE SENSORS

SENSOR	CODE
Accelerometers	
3-Axis Accelerometer	3D-BTA
25-g Accelerometer	ACC-BTA
Low-g Accelerometer	LGA-BTA
Anemometer	ANM-BTA
Barometer	BAR-BTA
Blood Pressure Sensor	BPS-BTA
Charge Sensor	CRG-BTA
CO_2 Gas Sensor	CO2-BTA
Colorimeter	COL-BTA
Conductivity Probe	CON-BTA
Constant Current System	CCS-BTA
Current Probes	
Current Probe	DCP-BTA
High Current Sensor	HCS-BTA
Diffraction Apparatus	DAK
IMPROVED Digital Control Unit †	DCU-BTD
Dissolved Oxygen Probes	
Dissolved Oxygen Probe	DO-BTA
Optical DO Probe	ODO-BTA
IMPROVED Drop Counter	VDC-BTD
Dual-Range Force Sensor	DFS-BTA
EKG Sensor	EKG-BTA
Electrode Amplifier	EA-BTA
Ethanol Sensor	ETH-BTA
Flow Rate Sensor	FLO-BTA
Force Plate	FP-BTA
Gas Pressure Sensor	GPS-BTA
Goniometer	GNM-BTA
Hand Dynamometer	HD-BTA
Hand-Grip Heart Rate Monitor	HGH-BTA
Instrumentation Amplifier	INA-BTA

SENSOR	CODE
Ion-Selective Electrodes	
Ammonium Ion-Selective Electrode	NH4-BTA
Calcium Ion-Selective Electrode	CA-BTA
Chloride Ion-Selective Electrode	CL-BTA
Nitrate Ion-Selective Electrode	NO3-BTA
NEW Potassium Ion-Selective Electrode	K-BTA
Light Sensor	LS-BTA
Magnetic Field Sensor	MG-BTA
Mass (Ohaus Balances)	
Scout Pro 0.01 g (200 g)	OHSP-202
Scout Pro 0.01 g (400 g)	OHSP-402
Scout Pro 0.001 g (120 g)	OHSP-123
Melt Station	MLT-BTA
Microphone	MCA-BTA
Mini GC Plus	GC2-MINI
Motion Detectors	
Go!Motion Motion Detector	GO-MOT
Motion Detector	MD-BTD
NEW Motion Encoder System – *see pp. 96–97*	
O_2 Gas Sensor	O2-BTA
ORP Sensor	ORP-BTA
NEW PAR Sensor	PAR-BTA
pH Sensors	
pH Sensor	PH-BTA
pH Sensor, Tris-Compatible Flat	FPH-BTA
Photogate	VPG-BTD
Polarimeter (Chemical)	CHEM-POL
Power Amplifier	PAMP
Projectile Launcher	VPL
Pyranometer	PYR-BTA
Radiation Monitors	
Vernier Radiation Monitor	VRM-BTD
Radiation Monitor *(Digital)*	DRM-BTD

SENSOR	CODE
Relative Humidity Sensor	RH-BTA
Respiration Monitor Belt *(requires GPS-BTA)*	RMB
Rotary Motion Sensor	RMV-BTD
Salinity Sensor	SAL-BTA
Soil Moisture Sensor	SMS-BTA
Sound Level Meter	SLM-BTA
Spectrometers	
SpectroVis Plus Spectrophotometer	SVIS-PL
NEW Vernier Emissions Spectrometer	VSP-EM
NEW Vernier UV-VIS Spectrophotometer	VSP-UV
Ocean Optics Spectrometers	
Vernier Spectrometer	V-SPEC
Spirometer	SPR-BTA
Temperature Probes	
Extra-Long Temperature Probe	TPL-BTA
Go!Temp Temperature Probe	GO-TEMP
NEW Go Wireless Temp*	GW-TEMP
Infrared Thermometer	IRT-BTA
Stainless Steel Temperature Probe	TMP-BTA
Surface Temperature Sensor	STS-BTA
Thermocouple	TCA-BTA
Wide-Range Temperature Probe	WRT-BTA
Turbidity Sensor	TRB-BTA
UV Sensors	
UVA Sensor	UVA-BTA
UVB Sensor	UVB-BTA
Voltage Probes	
Differential Voltage Probe	DVP-BTA
Voltage Probe	VP-BTA
30-Volt Voltage Probe	30V-BTA
Watts Up Pro	WU-PRO
Wireless Dynamics Sensor System	WDSS

* LabQuest 2 – Model: LQ2-LE only. † Use with computers only.

For more information about sensors, see pp. 126–147

Did you know?

The original LabQuest and LabQuest 2 can print directly to most HP printers. Simply connect LabQuest to the printer with a standard USB cable. You can also use Wi-Fi connectivity to connect to HP printers on your school network or directly to Wi-Fi enabled HP printers.

Built-in Stopwatch

On-board Scientific Calculator

a. LabQuest Viewer, ORDER CODE LQ-VIEW
LabQuest Viewer (electronic download), LQ-VIEW-E

Teach students how to use LabQuest by projecting your LabQuest screen via Wi-Fi. Use built-in Wi-Fi on LabQuest 2 to remotely monitor student progress by viewing student LabQuests. Compatible with both Mac and PC.

Computer software includes a site license for every teacher's computer in your school or college department.

LabQuest Viewer is also available for iPad. See page 26.

Watch for new features coming in spring 2014—free upgrade!

b. LabQuest 2 Lab Armor, ORDER CODE LQ2-ARMOR

Add extra protection from spills and falls with Lab Armor for LabQuest 2. Molded rubber material helps prevent spills from getting into open ports.

c. LabQuest Lanyard, ORDER CODE LQ-LAN

This lanyard connects to the back of your LabQuest, so you don't have to worry about students dropping their interface during field studies.

d. LabQuest 2 Charging Station, ORDER CODE LQ2-CRG

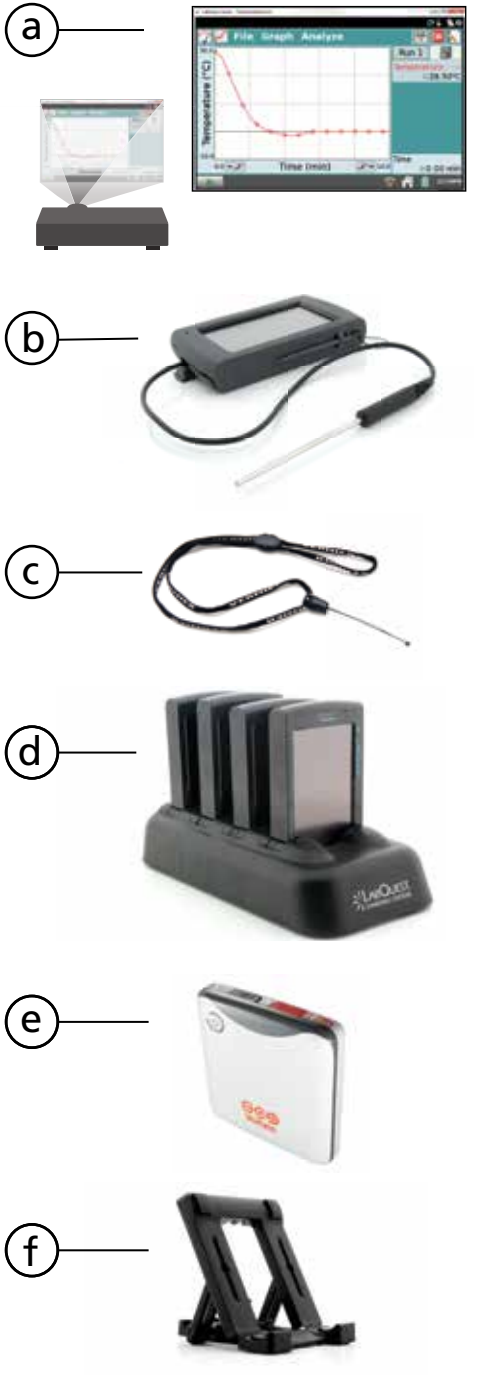
Want a way to charge and store your LabQuest 2 units? The LabQuest 2 Charging Station is the perfect solution. Each charging station has four charging slots. LEDs on the charging station indicate the charging status. Note: If you have original LabQuests, see page 150.

e. LabQuest Battery Boost 2, ORDER CODE LQ-BOOST2

The Battery Boost 2 is a rechargeable external battery for your original LabQuest or LabQuest 2. Data can be collected for extended periods in the field where AC power is not available.

f. LabQuest Stand, ORDER CODE LQ2-STN

Use this stand to set LabQuest 2 at an angle for easier viewing. The stand can also reduce the possibility of damage due to spills by raising LabQuest 2 off of the lab bench.



LabQuest MINI

ORDER CODE
LQ-MINI

Affordable. Powerful. Easy to Use.

LabQuest Mini brings the power of Vernier's award-winning LabQuest technology to teachers who don't need the versatility of a standalone device. The perfect solution for educators collecting data with a computer, LabQuest Mini interfaces with Logger Lite and Logger *Pro* software for unparalleled power, analysis, and curricular support.

Key features include:

- 100 kHz maximum sampling rate gives you the unrivaled power of LabQuest.
- Five sensor ports give you the flexibility to choose from over 70 compatible sensors.

"Excellent product that will serve many classroom environments well."
– Tech & Learning

FIVE TOTAL SENSOR PORTS

Three Analog Sensor Ports
For use with 60 compatible sensors, such as temperature, pH, and force.

Two Digital Sensor Ports
For use with digital sensors, such as motion detectors, photogates, chemical polarimeters, diffraction apparatus, and drop counters.

COLLECTING DATA EXCLUSIVELY ON COMPUTERS?

LabQuest Mini may be perfect for you!

- You can download our FREE Logger Lite software from our web site to get your students quickly collecting and analyzing data.
- Looking for more advanced features than Logger Lite provides? Our award-winning Logger *Pro* 3 software provides advanced analytical features including video analysis. See pp. 22–25 for additional details.
- Use with over 20 Vernier lab books covering core topics in Biology, Chemistry, Earth Science, Engineering, Environmental Science, Physical Science, Physics, Physiology, and Water Quality.

TECHNICAL SPECIFICATIONS

Computer Connection:
USB 2.0 Full Speed

Software Requirements:
Logger *Pro* 3.8.2 or newer
or Logger Lite 1.5 or newer

Analog Inputs: 3

Digital Inputs: 2

Sampling Rate:
100,000 samples per second

LABQUEST MINI COMPATIBLE SENSORS* AND DEVICES

SENSOR	CODE	SENSOR	CODE	SENSOR	CODE
Accelerometers		Gas Pressure Sensor	GPS-BTA	Pyranometer	PYR-BTA
3-Axis Accelerometer	3D-BTA	Goniometer	GNM-BTA	Radiation Monitors	
25-g Accelerometer	ACC-BTA	Hand Dynamometer	HD-BTA	Vernier Radiation Monitor †	VRM-BTD
Low-g Accelerometer	LGA-BTA	Hand-Grip Heart Rate Monitor	HGH-BTA	Radiation Monitor † (Digital)	DRM-BTD
Anemometer	ANM-BTA	Instrumentation Amplifier	INA-BTA	Relative Humidity Sensor	RH-BTA
Barometer	BAR-BTA	Ion-Selective Electrodes		Respiration Monitor Belt (requires GPS-BTA)	RMB
Blood Pressure Sensor	BPS-BTA	Ammonium Ion-Selective Electrode	NH4-BTA	Rotary Motion Sensor †	RMV-BTD
Charge Sensor	CRG-BTA	Calcium Ion-Selective Electrode	CA-BTA	Salinity Sensor	SAL-BTA
CO_2 Gas Sensor	CO2-BTA	Chloride Ion-Selective Electrode	CL-BTA	Soil Moisture Sensor	SMS-BTA
Colorimeter	COL-BTA	Nitrate Ion-Selective Electrode	NO3-BTA	Sound Level Meter	SLM-BTA
Conductivity Probe	CON-BTA	NEW Potassium Ion-Selective Electrode	K-BTA	Spirometer	SPR-BTA
Constant Current System	CCS-BTA	Light Sensor	LS-BTA	Temperature Probes	
Current Probes		Magnetic Field Sensor	MG-BTA	Extra-Long Temperature Probe	TPL-BTA
Current Probe	DCP-BTA	Melt Station †	MLT-BTA	Infrared Thermometer	IRT-BTA
High Current Sensor	HCS-BTA	Microphone	MCA-BTA	Stainless Steel Temperature Probe	TMP-BTA
Diffraction Apparatus	DAK	Motion Detector	MD-BTD	Surface Temperature Sensor	STS-BTA
IMPROVED Digital Control Unit †	DCU-BTD	NEW Motion Encoder System † – *see pp.96–97*		Thermocouple	TCA-BTA
Dissolved Oxygen Probes		O_2 Gas Sensor	O2-BTA	Wide-Range Temperature Probe	WRT-BTA
Dissolved Oxygen Probes	DO-BTA	ORP Sensor	ORP-BTA	Turbidity Sensor	TRB-BTA
Optical DO Probe	ODO-BTA	NEW PAR Sensor	PAR-BTA	UV Sensors	
IMPROVED Drop Counter †	VDC-BTD	pH Sensors		UVA Sensor	UVA-BTA
Dual-Range Force Sensor	DFS-BTA	pH Sensor	PH-BTA	UVB Sensor	UVB-BTA
EKG Sensor	EKG-BTA	pH Sensor, Tris-Compatible Flat	FPH-BTA	Voltage Probes	
Electrode Amplifier	EA-BTA	Photogate †	VPG-BTD	Differential Voltage Probe	DVP-BTA
Ethanol Sensor †	ETH-BTA	Polarimeter (Chemical) †	CHEM-POL	Voltage Probe	VP-BTA
Flow Rate Sensor	FLO-BTA	Power Amplifier	PAMP	30-Volt Voltage Probe	30V-BTA
Force Plate	FP-BTA	Projectile Launcher †	VPL		

* Sensors connected to a LabQuest Mini can be used in combination with our 11 supported USB sensors including Go!Temp, Go!Motion, Vernier GPS, and more. † Not supported with Logger Lite software

Go!Link®

USB Interface

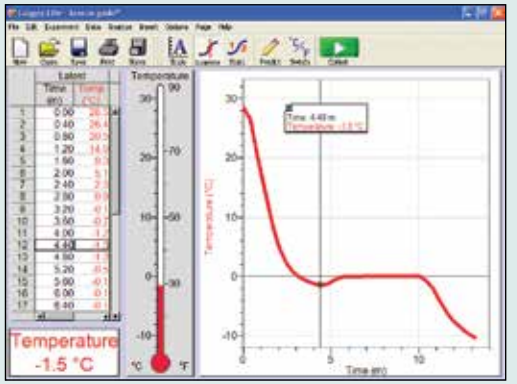
A quick and affordable way to get started with data-collection technology.

- Single-channel interface connects any one of 56 Vernier sensors to your computer's USB port. (See list of sensors below.)
- Dozens of experiments from our popular lab books can be conducted using Go!Link.

Go!Link, ORDER CODE **GO-LINK,** *Includes Logger Lite Software*

Teacher Pack of 8 Go!Links, ORDER CODE **GL-TP**
Includes Logger Lite Software

FREE LOGGER LITE SOFTWARE



Real-Time Graphing

Go!Link, Go!Temp, and Go!Motion include Logger Lite software with purchase.

Rather than tell students that water changes state at 0°C, let them see it for themselves! You can also investigate magnetic fields, gravity, and force with hands-on exploration and activities to help reinforce scientific concepts.

- Collect data using one or more sensors
- Calculate statistics
- Store runs
- Annotate graphs
- Print graphs
- Write reports
- Easily export data and graphs
- And much more!

Logger *Pro* 3

Logger *Pro* 3 software, ORDER CODE **LP**
Want to import experiment movies and synchronize data with video? For more advanced software features, you'll want Logger *Pro*. Buy just one copy—site license for **ALL school and students' personal computers** is included! See pp. 22-25.

GO!LINK COMPATIBLE SENSORS

SENSOR	CODE	SENSOR	CODE	SENSOR	CODE
Accelerometers		Goniometer	GNM-BTA	Relative Humidity Sensor	RH-BTA
25-g Accelerometer	ACC-BTA	Hand Dynamometer	HD-BTA	Respiration Monitor Belt *(Requires GPS-BTA)*	RMB
Low-g Accelerometer	LGA-BTA	Hand-Grip Heart Rate Monitor	HGH-BTA	Salinity Sensor	SAL-BTA
Anemometer	ANM-BTA	Instrumentation Amplifier	INA-BTA	Soil Moisture Sensor	SMS-BTA
Barometer	BAR-BTA	Ion-Selective Electrodes		Sound Level Meter	SLM-BTA
Blood Pressure Sensor	BPS-BTA	Ammonium Ion-Selective Electrode	NH4-BTA	Spirometer	SPR-BTA
Charge Sensor	CRG-BTA	Calcium Ion-Selective Electrode	CA-BTA	Temperature Probes	
CO_2 Gas Sensor	CO2-BTA	Chloride Ion-Selective Electrode	CL-BTA	Extra-Long Temperature Probe	TPL-BTA
Colorimeter	COL-BTA	Nitrate Ion-Selective Electrode	NO3-BTA	Infrared Thermometer	IRT-BTA
Conductivity Probe	CON-BTA	NEW Potassium Ion-Selective Electrode	K-BTA	Stainless Steel Temperature Probe	TMP-BTA
Constant Current System	CCS-BTA	Light Sensor	LS-BTA	Surface Temperature Sensor	STS-BTA
Current Probes		Magnetic Field Sensor	MG-BTA	Thermocouple	TCA-BTA
Current Probe	DCP-BTA	Melt Station	MLT-BTA	Wide-Range Temperature Probe	WRT-BTA
High Current Sensor	HCS-BTA	O_2 Gas Sensor	O2-BTA	Turbidity Sensor	TRB-BTA
Dissolved Oxygen Probe	DO-BTA	ORP Sensor	ORP-BTA	UV Sensors	
Dual-Range Force Sensor	DFS-BTA	NEW PAR Sensor	PAR-BTA	UVA Sensor	UVA-BTA
EKG Sensor	EKG-BTA	pH Sensors		UVB Sensor	UVB-BTA
Electrode Amplifier	EA-BTA	pH Sensor	PH-BTA	Voltage Probes	
Flow Rate Sensor	FLO-BTA	pH Sensor, Tris-Compatible Flat	FPH-BTA	Differential Voltage Probe	DVP-BTA
Force Plate	FP-BTA	Power Amplifier	PAMP	Voltage Probe	VP-BTA
Gas Pressure Sensor	GPS-BTA	Pyranometer	PYR-BTA	30-Volt Voltage Probe	30V-BTA

Go!Temp®

USB Temperature Probe

Go!Temp plugs directly into your computer's USB port without the need for an additional interface. This rugged, stainless-steel temperature probe engages your students in hands-on science as they explore temperature investigations. Compatible with Mac OS X and Windows.

Tech Specs:
Range: -20 to 115°C
Max temp without damage: 150°C

Go!Temp
ORDER CODE **GO-TEMP**
Includes Logger Lite Software

Teacher Pack of 8 Go!Temps
ORDER CODE **GT-TP**
Includes one copy of Logger Lite Software

MultiMedia & Internet@Schools

Go!Motion®

USB Motion Detector

- Teach important concepts in physics and physical science, such as position, velocity, and acceleration.
- Study the motion of a ball tossed in the air or a cart on a ramp.
- Engage your students with hands-on activities.

Go!Motion
ORDER CODE **GO-MOT**
Includes Logger Lite Software

Teacher Pack of 8 Go!Motions
ORDER CODE **GO-MOT-TP**
Includes one copy of Logger Lite Software

Head pivots to align with your experiment

Sensitivity switch optimizes data collection to suit your apparatus

Connects directly to a USB port (USB cable included)

MORE ONLINE – Go!Motion can also be used with Logger *Pro* software. Go!Motion can be used with LabPro, LabQuest 2, LabQuest, LabQuest Mini, CBL 2, TI-Nspire Lab Cradle, or a TI graphing calculator. Visit our web site for more information at **www.vernier.com/go-mot**

GO! QUICK-START PACKAGE

ORDER CODE **GO-QSP**

Includes:

- Go! Link interface and FREE Logger Lite Software
- Our award-winning Go!Temp USB temperature probe
- A TI Light Probe for measuring light intensity

Logger *Pro* 3

Real-Time Graphing and Powerful Analytical Tools

Logger *Pro* is our flagship data-collection and analysis application for Windows and Mac. With the complete suite of data collection and analysis tools, Logger *Pro* is suitable for all students, beginning to advanced.

- Logger *Pro* is the most popular data-collection program in science education. Why? Teachers tell us that students find our software to be very easy and intuitive to use.
- One program does it all for all of your computers AND your students' personal computers.
- Think of Logger *Pro* as the digital data hub of your classroom and lab. It can gather data from a variety of sources, including LabQuest 2, original LabQuest, LabQuest Mini, LabPro, Go! devices, Ohaus balances, compatible TI graphing calculators, spectrometers, GPS units, manual entry, and more. And now, Logger *Pro* shares data wirelessly with iPad, Android tablets, and other mobile devices.

Don't need all this power or working with younger students? Logger Lite, a streamlined subset of Logger *Pro*, is available at no charge for use with LabQuest 2, LabQuest Mini, Go!Temp, Go!Link, and Go!Motion.

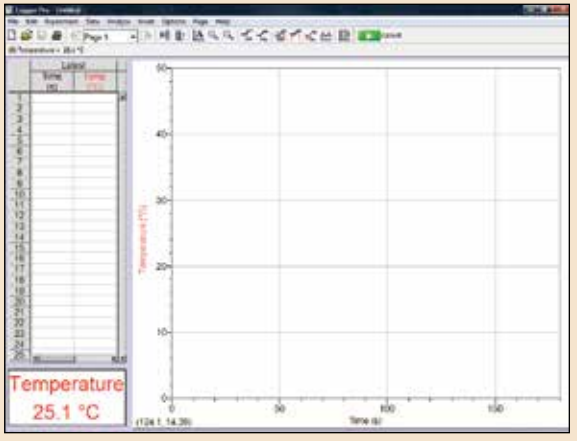
AWARD-WINNING

LOGGER *PRO* 3 GREAT VALUE!

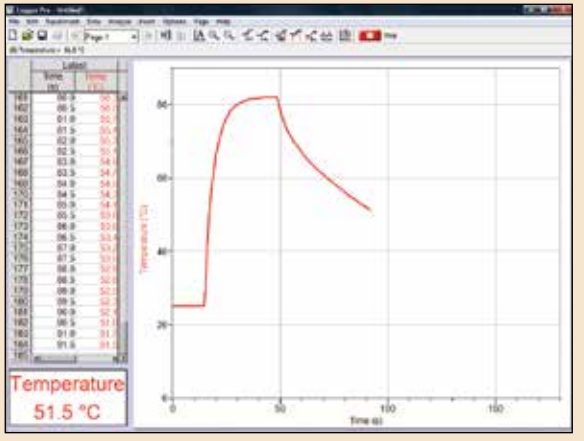
- Logger *Pro* 3 includes a site license for your entire school or college department.
- Site license includes home computers of faculty.
- Site license includes home computers of students—let them take it home!
- No need to count computers to satisfy licensing.
- Logger *Pro* 3 updates are free.
- Logger *Pro* 3 Data Sharing
  - Supports Graphical Analysis for iPad and Android and Vernier Data Share web app for other mobile devices and computers.
  - Streams data to multiple devices, allowing for 1:1 learning in lab groups and classrooms.

Logger *Pro* 3 (with manual and CD), ORDER CODE **LP**
Logger *Pro* 3 (electronic download), ORDER CODE **LP-E**

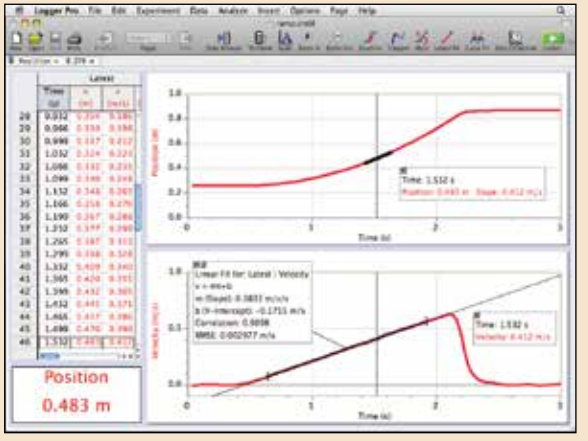
Provide an email address to which we will send download information.



Start Logger Pro *with a temperature sensor connected. A graph, data table, and meter are all ready to go. Click Collect, and you're taking data.*



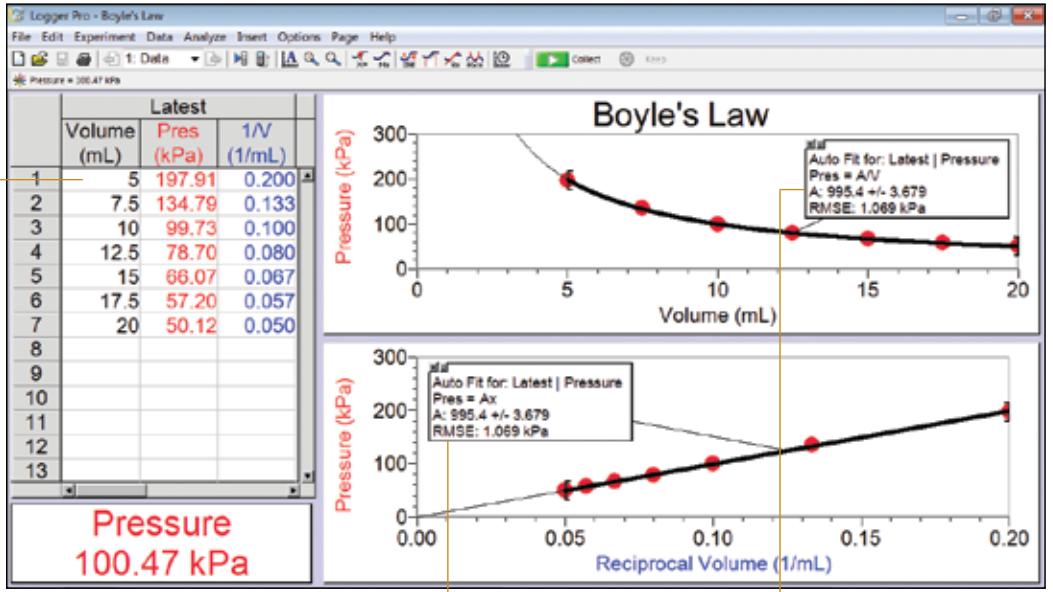
After you click Collect, Logger Pro *draws the graph in real time, and the data table and digital meter update continuously.*



Draw tangent lines to find local slopes and fit lines to selected regions—the analysis tools you need in Logger Pro *are at your fingertips.*

Basic Features

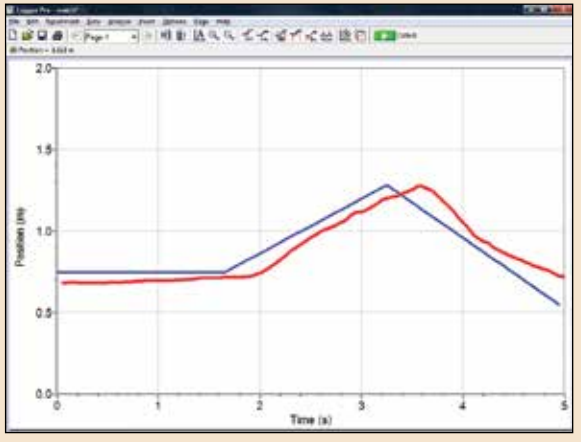
- Ease of use: connect a sensor, launch Logger *Pro,* and click Collect. Auto-ID sensors make setup effortless.
- Collect live data from more than 80 different sensors and devices.
- Draw predictions on a graph before collecting data.
- Use a variety of data-collection modes as needed for your experiment: time-based data, selected events, events with typed-in entries, photogate, radiation counting, and more.
- Manually enter data for graphing and analysis. All of the functions of Vernier's popular Graphical Analysis desktop application are available in Logger *Pro*.
- Import data from LabQuest and calculators.
- Lay out graphs, tables, and text as needed across multiple pages to describe your experiment.
- Read values and slope from graphs using examine and tangent line tools.
- Print graphs and data tables.



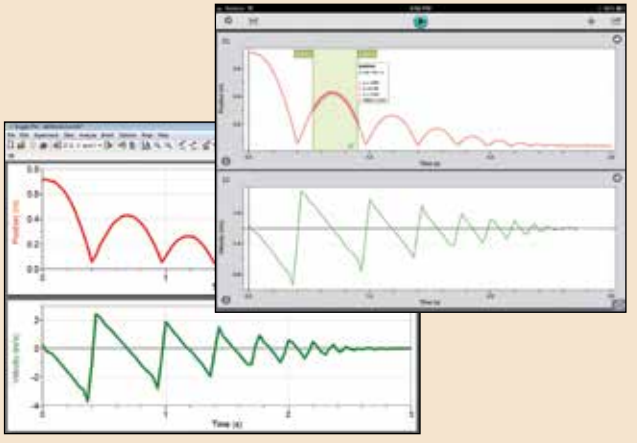
See data presented in many ways: tables, graphs, curve fits, and more.

Replot data to show new relationships.

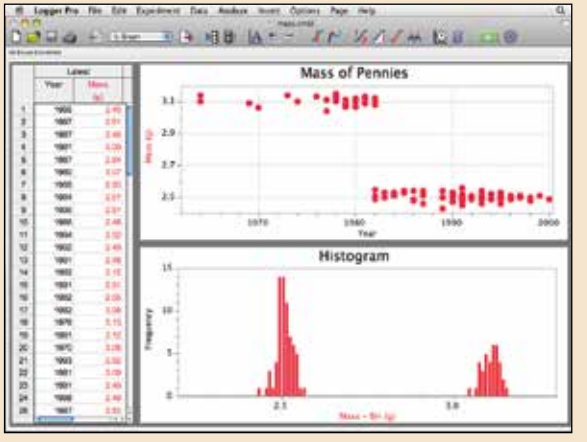
Curve fits show uncertainties in fit parameters. Choose from a library of built-in functions or enter your own.



Logger Pro *automatically creates target graphs for graph-matching exercises.*

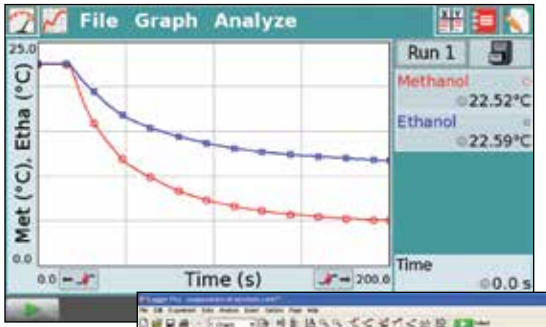


Share Logger Pro *data with Graphical Analysis for iPad.*

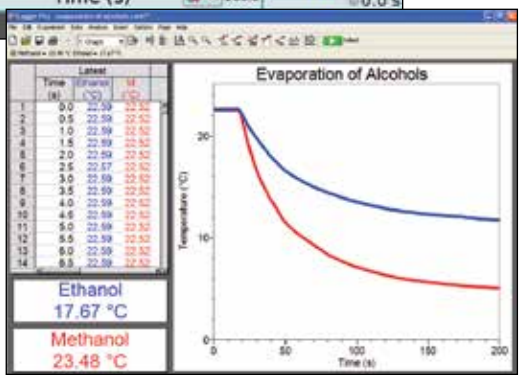


Logger Pro *includes all the premier analysis tools of desktop Graphical Analysis. Use directly captured sensor data, as well as imported and manually entered data.*

Easily download your data from LabQuest App to a computer for further analysis with Logger *Pro* software.



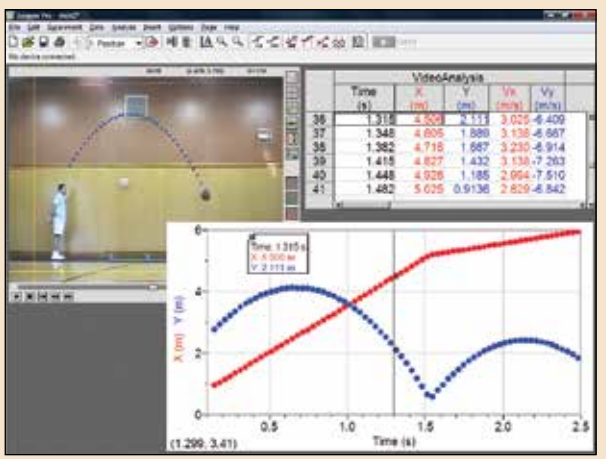
LabQuest App



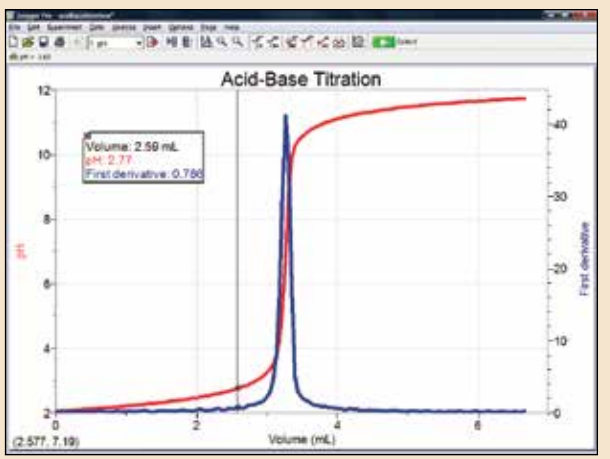
Logger Pro

Advanced Features

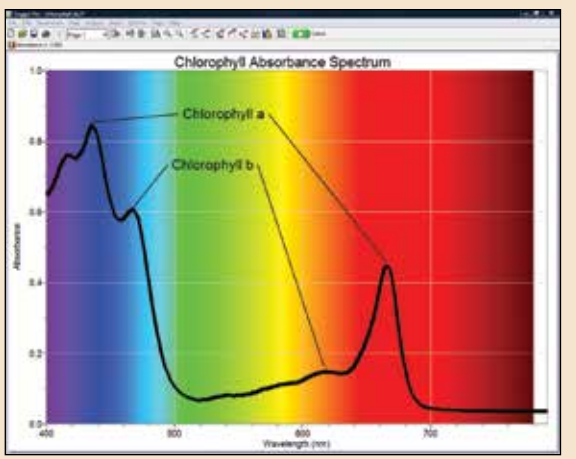
- Graph data in a variety of ways, including XY graphs, log graphs, double-Y graphs, strip charts, and FFT graphs.
- Model data with user-adjustable functions.
- Extract data from movies using frame-by-frame video analysis.
- Capture video from DV cameras and web cameras or import compatible movie files.
- Sync movie playback with sensor data.
- Analyze images of gel electrophoresis.
- Calculated columns allow you to graph new quantities, such as kinetic energy.
- Enhance graphs with date and time stamps.
- Use with Vernier and Ocean Optics spectrometers.
- Geolocate and map sensor data with GPS support.
- Perform GC peak analysis.
- Meet IB course goals with manual configuration mode.



Analyze videos to study the motion of individual or multiple objects. This feature alone is worth the price of Logger Pro*!*



Create double-Y graphs to tell complex stories with simplicity.



Collect absorbance data from the SpectroVis Plus, Vernier UV-VIS Spectrophotometer, or Ocean Optics Spectrometers.

LOGGER *PRO* IS COMPATIBLE WITH:

Vernier LabQuest 2 and Original LabQuest – Collect live data from LabQuest, retrieve existing data, or open saved files on LabQuest. Compatible with over 80 different sensors.

Vernier LabQuest Mini – Connect a LabQuest Mini and use over 70 different sensors.

Vernier LabPro – Connect a LabPro to collect data with over 70 sensors.

Go!Temp, Go!Link, and Go!Motion – Connect any of our Go! sensors and get advanced analysis tools in Logger *Pro*.

Wireless Dynamics Sensor System – See real-time graphing of acceleration, force, and altitude data via wireless Bluetooth connection.

Spectrometers – Collect data directly from Vernier and Ocean Optics spectrometers.

Graphical Analysis for iPad and Android – View and analyze data streamed from Logger *Pro* to multiple tablets and auto-save data for later work.

Digital Bioimaging System/ProScope HR – Capture images and study DNA with Logger *Pro*'s gel analysis feature.

Vernier Mini GC Plus – Collect and analyze gas chromatography data with peak analysis features.

TI Graphing Calculators – Use a TI Connectivity Cable to import data into Logger *Pro* from supported TI graphing calculators.

Vernier GPS Sensor – Record latitude, longitude, altitude, speed, and direction, along with data collected from other sensors. Create spatial visualizations with built-in Google Maps export.

Video Clips – Capture video clips and synchronize with sensor data or perform video analysis.

Manual Entry – Enter data manually, do further analysis, or write lab reports.

Chromebooks – View and analyze Logger *Pro* data in the Chrome™ browser and continue work later in offline mode.

Teach Graphing and Analysis Skills with Logger *Pro*

High School

- Calculated columns allow graphing of derived data; for example, plot the square of the pendulum length for one axis
- Modeling feature lets students superimpose mathematical functions on their data

Middle School

- Easy unit switching helps teach measurement units
- Time-of-day graphs for weather or other long-term studies

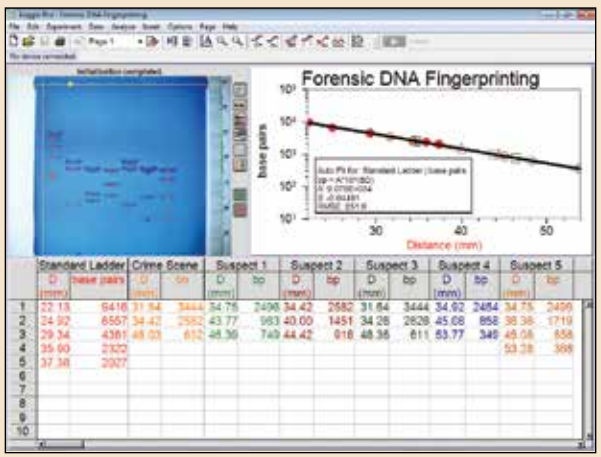
College and University

- Includes advanced graphing features like log graphs and semi-log graphs
- Custom curve fits allow sophisticated models
- Compatible with advanced Ocean Optics spectrometers

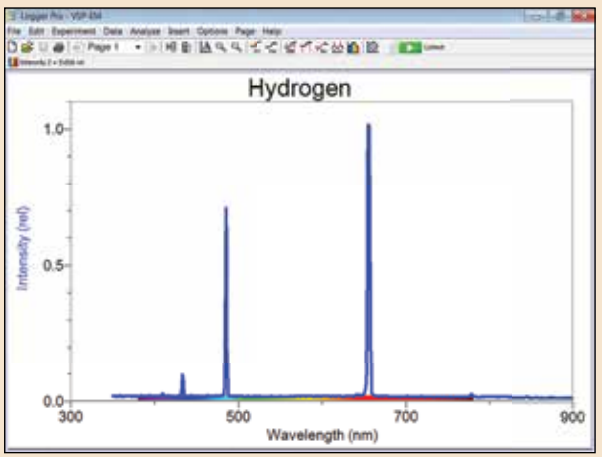
Logger *Pro* 3, ORDER CODE **LP**
One CD for Mac OS X and Windows

Logger *Pro* Student 5-Pack, ORDER CODE **LP-ST5**

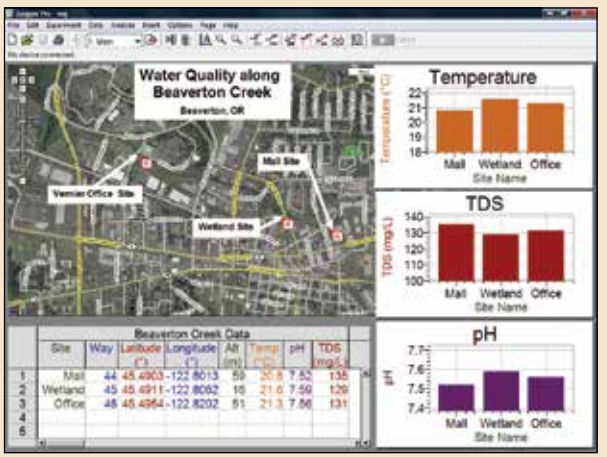
See **www.vernier.com/loggerpro** for upgrade and system compatibility information



Use our Blue Digital Bioimaging System, along with Logger Pro, *to analyze gel electrophoresis data.*



Use the Vernier Emissions Spectrometer to study emission lines from discharge lamps.



Export water quality data to Google Maps and incorporate the result into a Logger Pro *page.*

LabQuest Viewer™ for iPad

LabQuest Viewer for iPad app allows you to wirelessly view and control LabQuest from your iPad. When used with a projector, you can display any LabQuest screen for the entire class. Share the instructor LabQuest screen for demos or share students' LabQuests for class presentations.

Use LabQuest Viewer for iPad in the classroom to

- View and control a LabQuest unit from an iPad, project its screen, or do a class demo
- Control the projected LabQuest directly from the LabQuest or iPad
- Monitor student progress by wirelessly connecting to any LabQuest on your network
- Create screenshots of a LabQuest screen that you can paste into lab instructions and other documents

Requires iOS 7 or newer.

For more info, visit **www.vernier.com/lq-view-ipad**

LabQuest Viewer for iPad is sold only through the App Store. It is a separate purchase from the LabQuest Viewer computer software.

View and control any LabQuest on your network directly from your iPad.

Available on the App Store

Video Physics

Perform Video Analysis on iPad, iPhone, and iPod touch

Video Physics is perfect for physics students and instructors to perform on-the-go analysis of motion. Measure the velocity of a swing, a roller-coaster, or a basketball free-throw shot.

Use Video Physics for iPad in the classroom to

- Capture a new video using the built-in camera, choose a video from your Photo Library, or use one of our sample videos
- Mark the position of one object, frame by frame
- Set the scale of the video using an object of known size
- Optionally set the coordinate system location and rotation
- View graphs of trajectory, X and Y position, and velocity
- Export the marked video to your Photo Library. Graphs are appended to video
- Email the video and data for further analysis in Vernier's Logger *Pro* software for OS X and Windows
- Open data files directly in Graphical Analysis for iPad
- Open data files in Dropbox or Google Drive to upload to the cloud

For more information, visit **www.vernier.com/videophysics**

Video analysis of an accelerating Segway®

Available on the App Store

APP of the week

AWARDS of EXCELLENCE winner!

BEST EDUCATIONAL SOFTWARE AWARDS
Winner of 19TH ANNUAL
BESSIE AWARDS

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Primary Productivity using the Vernier Optical DO Probe and PAR Sensor

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1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest, computers, and TI graphing calculators.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

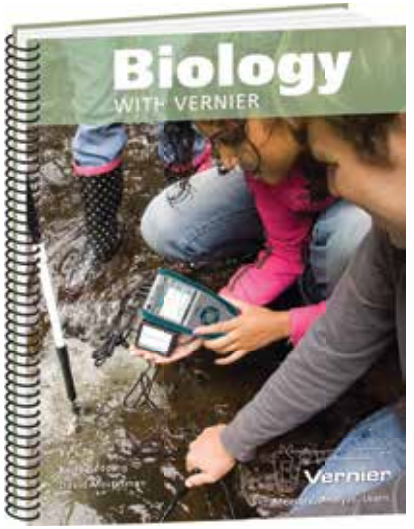
Our Deluxe Package contains all the sensors needed to perform every experiment in our biology lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



BIOLOGY LAB BOOK

ORDER CODE **BWV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 31 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/bwv**

Biology with Vernier lab book contains the following experiments:

☐ ☐ **USING TEMPERATURE PROBES**
- Biodiversity and Ecosystems
- Energy in Food
- Aerobic Respiration
- Dissolved Oxygen in Water
- Watershed Testing
- Physical Profile of a Lake

☐ ☐ **USING A GAS PRESSURE SENSOR**
- Testing Catalase Activity
- Transpiration
- Cell Respiration
- Sugar Fermentation
- Effect of Temperature on Fermentation
- Osmosis
- Lactase Action
- Control of Human Respiration

☐ **USING AN EKG SENSOR**
- Monitoring EKG

☐ ☐ **USING A HEART RATE MONITOR**
- Heart Rate and Physical Fitness
- Ventilation and Heart Rate

☐ ☐ **USING A CO_2 GAS SENSOR**
- ▶ Cell Respiration
- Respiration of Sugars by Yeast
- Effect of Temperature on Respiration
- Temperature of Cold-Blooded Organisms
- Lactase Action
- Photosynthesis and Respiration

☐ **USING A COLORIMETER**
- Photosynthesis
- Alcohol & Biological Membranes
- Biological Membranes
- Population Dynamics

☐ **USING A RESPIRATION MONITOR BELT**
- Control of Human Respiration

☐ **USING AN O_2 GAS SENSOR**
- Photosynthesis and Respiration
- ▶ Enzyme Action
- ▶ Cell Respiration
- Oxygen Gas and Human Respiration
- Cold-Blooded Organisms

☐ **USING A CONDUCTIVITY PROBE**
- Limitations on Cell Size
- Diffusion through Membranes
- Conducting Solutions
- Watershed Testing
- Physical Profile of a Lake

☐ **USING A DISSOLVED OXYGEN PROBE**
- Interdependence of Plants and Animals
- Aerobic Respiration
- Dissolved Oxygen in Water
- Watershed Testing
- Physical Profile of a Lake
- Primary Productivity

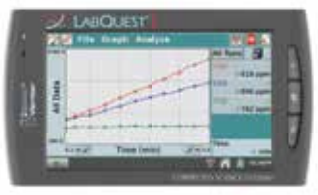
☐ **USING A pH SENSOR**
- Acids and Bases
- Interdependence of Plants and Animals
- Acid Rain
- Watershed Testing
- Physical Profile of a Lake

☐ STARTER PACKAGES ☐ DELUXE PACKAGES ▶ VIDEO ONLINE

Biology LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2



Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-BIO-ST	Deluxe Package LQ2-BIO-ODX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
CO_2 Gas Sensor	CO2-BTA	✔	✔
O_2 Gas Sensor	O2-BTA		✔
Conductivity Probe	CON-BTA		✔
pH Sensor	PH-BTA		✔
Colorimeter	COL-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
EKG Sensor	EKG-BTA		✔
BioChamber 250	BC-250		✔
BioChamber 2000	BC-2000		✔
Respiration Monitor Belt	RMB		✔

YOU MAY ALSO NEED:

Biology with Vernier **lab book,** ORDER CODE **BWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 BIOLOGY PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-BIO-ST	Deluxe Package LM-BIO-ODX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
CO_2 Gas Sensor	CO2-BTA	✔	✔
O_2 Gas Sensor	O2-BTA		✔
Conductivity Probe	CON-BTA		✔
pH Sensor	PH-BTA		✔
Colorimeter	COL-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
EKG Sensor	EKG-BTA		✔
BioChamber 250	BC-250		✔
BioChamber 2000	BC-2000		✔
Respiration Monitor Belt	RMB		✔

YOU MAY ALSO NEED:

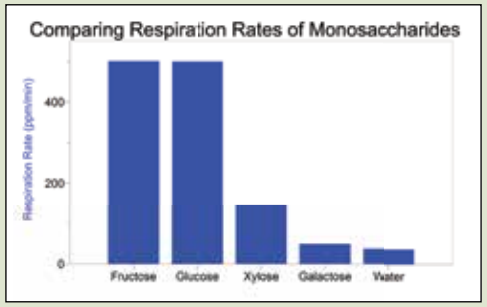
Biology with Vernier **lab book,** ORDER CODE **BWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI BIOLOGY PACKAGES

*Deluxe packages substituting a Dissolved Oxygen Probe for the Optical DO Probe are available online.

SUGAR METABOLISM WITH YEAST



Using a CO_2 Gas Sensor to measure the respiration rates of yeast-fed various monosaccharides

AP* BIOLOGY TEACHERS

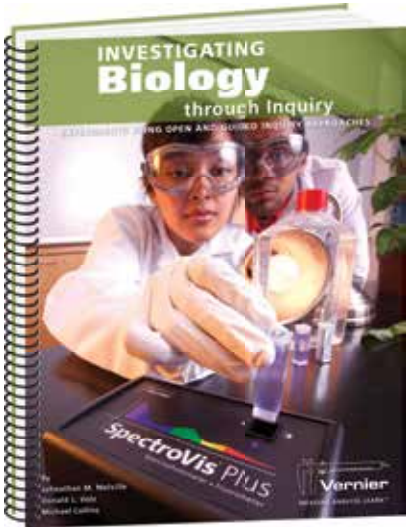
The AP Biology course supports inquiry-based lab experiences for students. Many of the experiments in *Investigating Biology through Inquiry* would fit perfectly. We recommend that AP Biology teachers purchase this book. For a complete correlation of Vernier labs with each of the Big Ideas in the AP Biology Framework, visit **www.vernier.com/ap**

IB† BIOLOGY TEACHERS

The International Baccalaureate program has a complete set of objectives for an IB Biology class at the standard level (SL) and the higher level (HL). Many of the experiments in *Investigating Biology through Inquiry* would fit perfectly. For a complete correlation of Vernier labs with IB Biology lab objectives, visit **www.vernier.com/ib**

*AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.



BIOLOGY INQUIRY LAB BOOK

ORDER CODE **BIO-I** GREAT VALUE!

Investigating Biology through Inquiry will help you integrate inquiry into your curriculum, whether you teach AP*, IB†, or college biology. This inquiry book is designed to meet the new requirements for inquiry in AP biology. This lab book is loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Complete student preliminary activities with step-by-step instructions, data tables, and questions
- Teacher Information section for each investigation with complete directions for setting up, helpful hints, and sample graphs and data
- Word-processing files of the student sections on a CD so that any investigation may be easily edited to your specifications (Microsoft® Word® files)
- CD includes both open and guided inquiry approaches to student preliminary activities

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/bio-i**

Investigating Biology through Inquiry lab book includes the following investigations:

USING A TEMPERATURE PROBE
- Water Monitoring
- Sugar Metabolism with Yeast
- Fermentation with Yeast

USING A CONDUCTIVITY PROBE
- Diffusion
- Water Monitoring

USING AN O_2 GAS SENSOR
- Testing Catalase Activity (O_2)

USING A pH SENSOR
- Investigating Buffers
- Water Monitoring

USING A HEART RATE MONITOR
- Heart Rate

USING A CO_2 GAS SENSOR
- Cellular Respiration
- Sugar Metabolism with Yeast
- Evolution of Yeast: Artificial Selection

USING A DISSOLVED OXYGEN SENSOR
- Investigating Dissolved Oxygen
- Investigating Primary Productivity
- Water Monitoring

USING A GAS PRESSURE SENSOR
- Transpiration of Plants
- Testing Catalase Activity (Gas Pressure)
- Investigating Osmosis
- Fermentation with Yeast

USING A WHITE DIGITAL BIOIMAGING SYSTEM
- Introduction to Molecular Evolution

USING A SPECTROVIS PLUS
- Plant Pigments
- Chemistry of Membranes
- Photosynthesis of Chloroplasts
- Evolution of Cellobiase in Fungi
- Analysis of Enzymes using Tyrosinase
- Introduction to Biofuels: Enzyme Action
- Investigating Protein: The Bradford Assay

STARTER PACKAGES DELUXE PACKAGES VIDEO ONLINE

Did you know?

Vernier Optical DO Probe, ORDER CODE **ODO-BTA**

The Vernier Optical DO Probe makes it easy to measure the dissolved oxygen concentration in water. Perfect for the field or for the laboratory, this plug-and-play probe requires no calibration, no filling solution, no warm-up time, and no stirring. For more details, see page 39.

Biology Inquiry LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-BINQ-ST	Deluxe Package LQ2-BINQ-ODX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
SpectroVis Plus Spectrophotometer	SVIS-PL	✔	✔
CO_2 Gas Sensor	CO2-BTA		✔
Conductivity Probe	CON-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
O_2 Gas Sensor	O2-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
pH Sensor	PH-BTA		✔

YOU MAY ALSO NEED:

Investigating Biology through Inquiry **lab book** ORDER CODE **BIO-I**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 BIOLOGY INQUIRY PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-BINQ-ST	Deluxe Package LM-BINQ-ODX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
SpectroVis Plus Spectrophotometer	SVIS-PL	✔	✔
CO_2 Gas Sensor	CO2-BTA		✔
Conductivity Probe	CON-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
O_2 Gas Sensor	O2-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
pH Sensor	PH-BTA		✔

YOU MAY ALSO NEED:

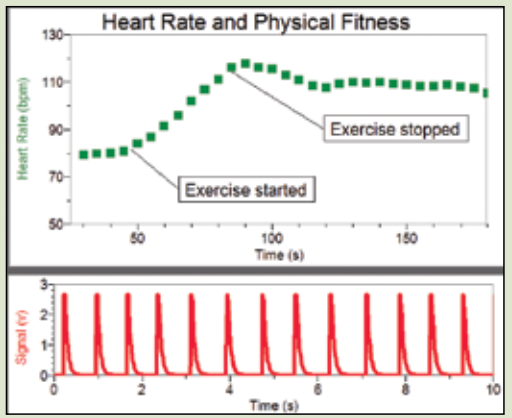
Investigating Biology through Inquiry **lab book** ORDER CODE **BIO-I**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI BIOLOGY INQUIRY PACKAGES

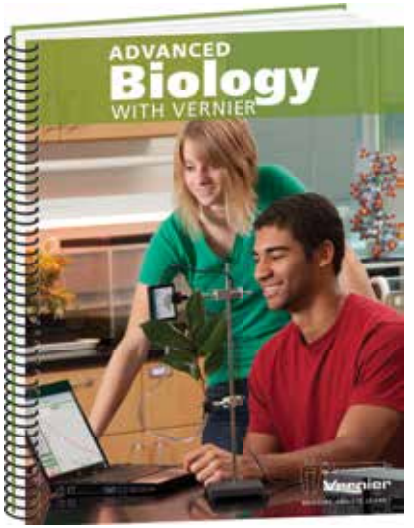
*Deluxe packages substituting a Dissolved Oxygen Probe for the Optical DO Probe are available online.

HEART RATE AND PHYSICAL FITNESS



Using a Hand-Grip Heart Rate Monitor to determine how exercise affects heart rate

Interested in Environmental Science, Agricultural Science, Human Physiology, or Forensics lab books? See pages 108 and 111.



ADVANCED BIOLOGY LAB BOOK

ORDER CODE **BIO-A** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 17 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class.
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/bio-a**

Advanced Biology with Vernier lab book contains the following experiments. (For inquiry-based biology experiments, see page 30.)

☐ ☐ **USING A TEMPERATURE PROBE**
- Dissolved Oxygen in Water

☐ ☐ **USING A GAS PRESSURE SENSOR**
- Transpiration
- ▶ Cell Respiration
- Osmosis
- Enzyme Action

☐ ☐ **USING A CO_2 GAS SENSOR**
- ▶ Cell Respiration

☐ ☐ **USING AN O_2 GAS SENSOR**
- ▶ Enzyme Action
- ▶ Cell Respiration

☐ ☐ **USING A HEART RATE MONITOR**
- Heart Rate and Physical Fitness

☐ ☐ **USING A COLORIMETER OR SPECTROVIS® PLUS SPECTROPHOTOMETER**
- Enzyme Analysis using Tyrosinase
- Introduction to Neurotransmitters using AChE
- Macromolecules: Experiments with Protein
- Photosynthesis

☐ ☐ **USING A CONDUCTIVITY PROBE**
- Diffusion through Membranes

☐ ☐ **USING A DISSOLVED OXYGEN PROBE**
- Dissolved Oxygen in Water

☐ ☐ **USING A SPECTROVIS PLUS SPECTROPHOTOMETER**
- Visible Spectra of Plant Pigments
- Determination of Chlorophyll in Olive Oil
- Enzyme Analysis using Tyrosinase
- Introduction to Neurotransmitters using AChE
- Macromolecules: Experiments with Protein

☐ ☐ **USING A BLOOD PRESSURE SENSOR**
- Blood Pressure as Vital Sign

(USING BIOIMAGING SYSTEMS)
- pGLO Bacterial Transformation
- Analysis of Precut Lambda DNA: An Introduction to Restriction Enzymes
- Forensic DNA Fingerprinting

NO SENSOR USED
- Mitosis and Meiosis
- Genetics of Drosophila
- Population Genetics and Evolution
- Animal Behavior

☐ STARTER PACKAGES ☐ DELUXE PACKAGES ▶ VIDEO ONLINE

Did you know?

Hand Dynamometer, ORDER CODE **HD-BTA**

Our strain-gage based isometric dynamometer can be used to measure grip strength or finger-pinch strength. The Hand Dynamometer makes a great addition to your biology labs. For more details on this sensor, see page 133.

Advanced Biology LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-AB-ST	SpectroVis Plus Deluxe LQ2-AB-OSV
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
Conductivity Probe	CON-BTA	✔	✔
CO_2 Gas Sensor	CO2-BTA	✔	✔
O_2 Gas Sensor	O2-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
Blood Pressure Sensor	BPS-BTA		✔
BioChamber 250	BC-250		✔
SpectroVis Plus Spectrophotometer*	SVIS-PL		✔

SPECTROVIS PLUS DELUXE

STARTER

YOU MAY ALSO NEED:

Advanced Biology with Vernier **lab book**
ORDER CODE **BIO-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 ADVANCED BIOLOGY PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-AB-ST	SpectroVis Plus Deluxe LM-AB-OSV
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
Conductivity Probe	CON-BTA	✔	✔
CO_2 Gas Sensor	CO2-BTA	✔	✔
O_2 Gas Sensor	O2-BTA		✔
Vernier Optical DO Probe*	ODO-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
Blood Pressure Sensor	BPS-BTA		✔
BioChamber 250	BC-250		✔
SpectroVis Plus Spectrophotometer*	SVIS-PL		✔

SPECTROVIS PLUS DELUXE

STARTER

YOU MAY ALSO NEED:

Advanced Biology with Vernier **lab book**
ORDER CODE **BIO-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI ADVANCED BIOLOGY PACKAGES

*Deluxe packages substituting a Dissolved Oxygen Probe for the Optical DO Probe and a Colorimeter for the SpectroVis Plus are available online.

a. Blue Digital Bioimaging System

ORDER CODE **BL-DBS**

The Blue Digital Bioimaging System is a complete solution for photodocumenting and analyzing your electrophoresis gels. With it, you can

- View your gel banding patterns using the BlueView Transilluminator
- Capture a photograph of the gel on your computer using a ProScope HR
- Analyze your results by creating a standard curve and calculating the number of base pairs in each band using Logger *Pro* software (not included)

The Blue Digital Bioimaging System includes a BlueView Transilluminator, Imaging Hood, ProScope HR digital USB camera with 1–10X lens, and a ProScope Stand.

NEW

b. NEW Vernier UV-VIS Spectrophotometer

ORDER CODE **VSP-UV**

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer. It is an easy and accurate instrument ideal for measuring the absorbance spectra of various biochemical compounds. It can also be used to measure DNA and protein purity and for various enzyme kinetic assays. As a USB device, it plugs directly into your computer or LabQuest.

Bio-Rad Forensic DNA Fingerprinting Kit

BIO-RAD Bio-Rad Partnership

Vernier and Bio-Rad have partnered to bring you the best in biotechnology kits, instrumentation, consumables, data collection, analysis, and curricula.

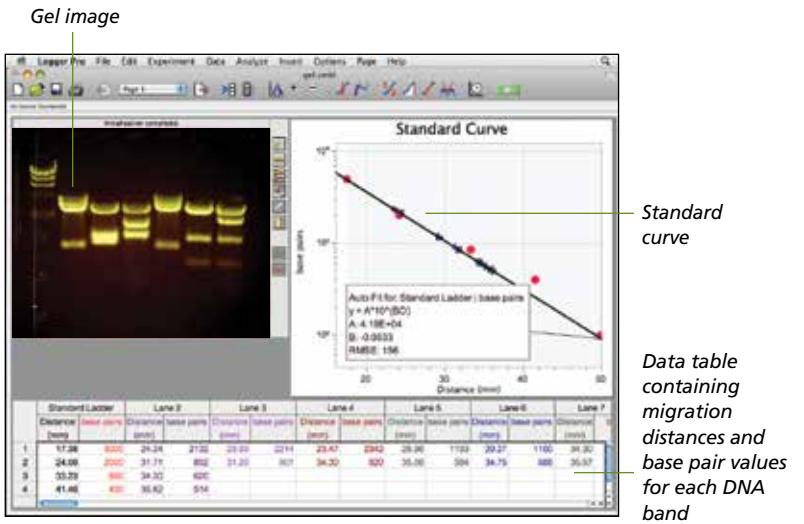
MORE ONLINE – For more information on biotechnology, visit **www.vernier.com/biotech**

Experiment 6B from Advanced Biology with Vernier, *"Analysis of Precut Lambda DNA"*

Three Easy Steps for Gel Analysis

Vernier provides tools for digital photodocumentation and analysis of gel electrophoresis. Here's how it's done:

1. Run your gel.
2. Use our Blue Digital Bioimaging System to capture a digital photo of the gel in Logger *Pro*.
3. Use the Gel Analysis feature in Logger *Pro* to create a standard curve and determine the number of base pairs in each experimental band.


Gel image
Standard Curve
Standard curve
Data table containing migration distances and base pair values for each DNA band

Using the Gel Analysis feature of Logger Pro *3*

"Plant Pigments" from Investigating Biology through Inquiry

SpectroVis® Plus

Spectrophotometer + Fluorometer

ORDER CODE **SVIS-PL**

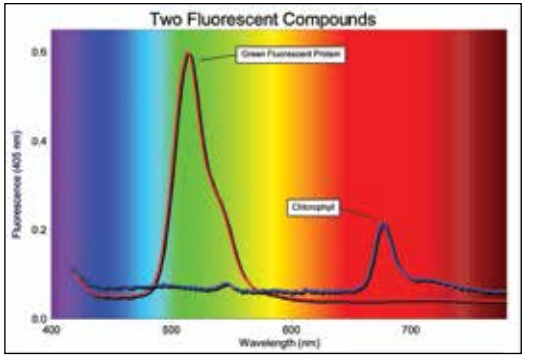
Having an array spectrophotometer/fluorometer combination is now affordable for each of your lab stations! SpectroVis Plus spectrophotometer plus fluorometer allows students to collect absorbance, transmittance, and fluorescence data quickly and easily. In absorbance mode, you can quickly and easily measure the absorbance spectrum of a solution, concentrations of solutions, and rates of reactions. With its two different excitation wavelengths, SpectroVis Plus can quantitatively measure the fluorescence spectra of many compounds, such as chlorophyll, fluorescein, GFP, and more. Connect SpectroVis Plus to a LabQuest or a computer running Logger *Pro* using a standard USB cable (included), and see the results in full color.

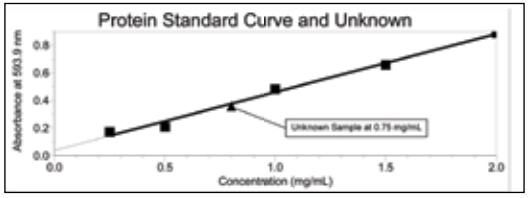
USES

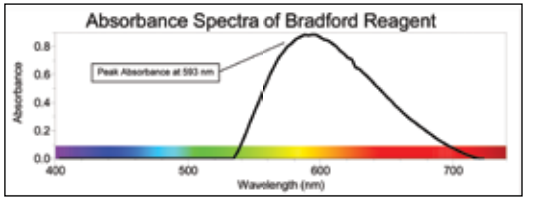
- Measure absorbance spectrum of a liquid
- Measure fluorescence emission spectrum of a liquid
- Conduct Beer's law investigations
- Conduct kinetic studies of absorbance *vs.* time
- Conduct equilibrium studies of absorbance *vs.* time and/or absorbance *vs.* concentration
- Conduct experiments on enzyme kinetics
- Perform colorimetric or fluorescent bioassays
- Use the Optical Fiber (sold separately) to measure light emissions of LEDs, fluorescent bulbs, or incandescent lights. For spectrum tube emissions, we recommend the Vernier Emissions Spectrometer on page 91.

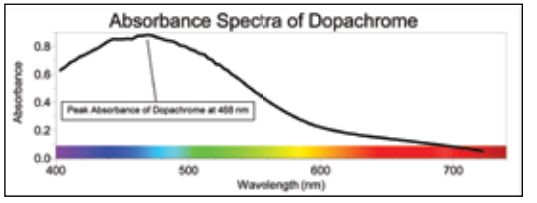
FEATURES

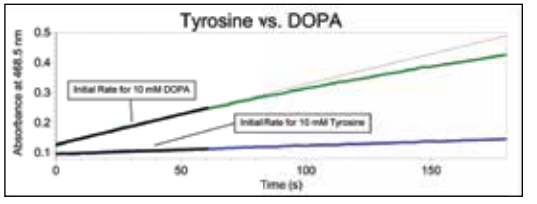
- Portable: 15 cm x 9 cm x 4 cm
- Easy one-step calibration
- Measures absorbance over a 380–900 nm range
- 570 wavelengths, 1 nm reporting intervals
- Fluorescence excitation centered at 405 nm or 500 nm
- Powered by computer or LabQuest USB port; no additional power source needed











Data from spectrometer labs in Advanced Biology with Vernier *and* Investigating Biology through Inquiry

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest and computers.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

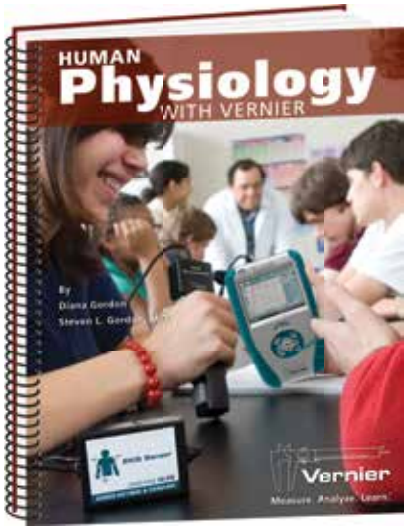
Our Deluxe Package contains all the sensors needed to perform every experiment in our physiology lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



HUMAN PHYSIOLOGY LAB BOOK

ORDER CODE **HP-A** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information.
- 24 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest and computer versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/hp-a**

Human Physiology with Vernier lab book contains the following experiments:

☐ **USING A SURFACE**
☐ **TEMPERATURE SENSOR**
- Warming Function of Nasal Passageways
- Effect of Vascularity on Skin Temperature Recovery

☐ **USING A BLOOD**
☐ **PRESSURE SENSOR**
- Blood Pressure as a Vital Sign
- Blood Pressure and Exercise
- Diurnal Blood Pressure Variation
- Heart Rate and Blood Pressure as Vital Signs
- Heart Rate, Blood Pressure, and Exercise

☐ **USING A HEART**
☐ **RATE MONITOR**
- ▶ Heart Rate as a Vital Sign
- Heart Rate and Exercise
- Heart Rate Response to Baroreceptor Feedback
- Effect of Coughing on Heart Rate
- Heart Rate and Blood Pressure as Vital Signs
- Heart Rate, Blood Pressure, and Exercise

☐ **USING A HAND DYNAMOMETER**
- Grip Strength Comparison
- Grip Strength and Muscle Fatigue
- EMG and Muscle Fatigue

☐ **USING AN EKG SENSOR**
- Analyzing the Heart with EKG
- Introduction to EMG
- Neuromuscular Reflexes (with Accelerometer)
- Neuromuscular Reflexes (without Accelerometer)
- Muscle Function Analysis
- EMG and Muscle Fatigue

☐ **USING A SPIROMETER**
- Lung Volumes and Capacities
- Respiratory Response to Physiologic Challenges
- Analysis of Lung Function
- Oxygen and Aerobic Metabolism

☐ **USING AN O_2 GAS SENSOR**
- Oxygen and Aerobic Metabolism
- Oxygen Extraction by the Lungs
- Effect of "Dead Space" on Oxygen Exchange

☐ **USING A 25-G ACCELEROMETER**
- Neuromuscular Reflexes (with Accelerometer)

☐ STARTER PACKAGES ☐ DELUXE PACKAGES ▶ VIDEO ONLINE

Look for training videos of some of these labs at **www.vernier.com/videos**

Did you know?

Our CO_2 Gas Sensor can be used to measure human respiration. The high range can measure up to 100,000 ppm, while the low range, with a maximum of 10,000 ppm, still gives the precision you need for smaller changes in CO_2 gas concentration. The CO_2 Gas Sensor makes a great addition to your human physiology labs. For more details on this sensor, see page 127.

Human Physiology LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-HP-ST	Deluxe Package LQ2-HP-DLX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
EKG Sensor	EKG-BTA	✔	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔	✔
Surface Temperature Sensor	STS-BTA	✔	✔
Blood Pressure Sensor	BPS-BTA	✔	✔
Hand Dynamometer	HD-BTA	✔	✔
Spirometer	SPR-BTA		✔
O_2 Gas Sensor	O2-BTA		✔
O_2 Gas Sensor to Spirometer Adapter	O2-SPR		✔
25-g Accelerometer	ACC-BTA		✔

YOU MAY ALSO NEED:

Human Physiology with Vernier **lab book,** ORDER CODE **HP-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 HUMAN PHYSIOLOGY PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-HP-ST	Deluxe Package LM-HP-DX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
EKG Sensor	EKG-BTA	✔	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔	✔
Surface Temperature Sensor	STS-BTA	✔	✔
Blood Pressure Sensor	BPS-BTA	✔	✔
Hand Dynamometer	HD-BTA	✔	✔
Spirometer	SPR-BTA		✔
O_2 Gas Sensor	O2-BTA		✔
O_2 Gas Sensor to Spirometer Adapter	O2-SPR		✔
25-g Accelerometer	ACC-BTA		✔

YOU MAY ALSO NEED:

Human Physiology with Vernier **lab book,** ORDER CODE **HP-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI HUMAN PHYSIOLOGY PACKAGES

O_2 Gas Sensor to Spirometer Adapter

ORDER CODE **O2-SPR**

This adapter facilitates the connection between an Oxygen Gas Sensor and a Spirometer. See page 143.

Goniometer

ORDER CODE **GNM-BTA**

The Goniometer measures the angle of a joint. Use it to analyze the range of motion of a limb during different types of physical activity. See page 133.

Force Plate

ORDER CODE **FP-BTA***

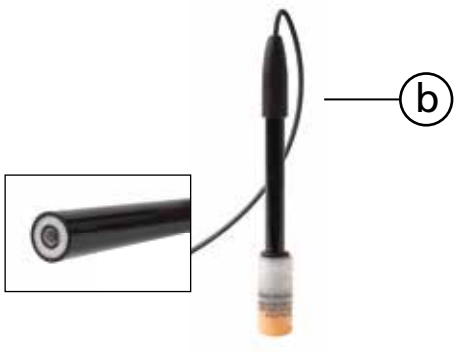
The Force Plate is a large force sensor—tough enough to jump on. Use it to study balance and biomechanics. See page 132.

*Additional shipping charges may apply.

a. Ethanol Sensor

ORDER CODE **ETH-BTA**

Use the Ethanol Sensor to measure the concentration of ethanol in air above an aqueous sample. It can be used to determine the rate of ethanol production during fermentation or to measure the discrete amount of ethanol in a given sample.



b. Tris-Compatible Flat pH Sensor

ORDER CODE **FPH-BTA**

The Tris-Compatible Flat pH Sensor uses a double-junction electrode, making it compatible with Tris buffers and solutions containing proteins. The flat glass shape also makes it ideal for measuring the pH of semisolids, such as food or soil.

c. NEW PAR Sensor

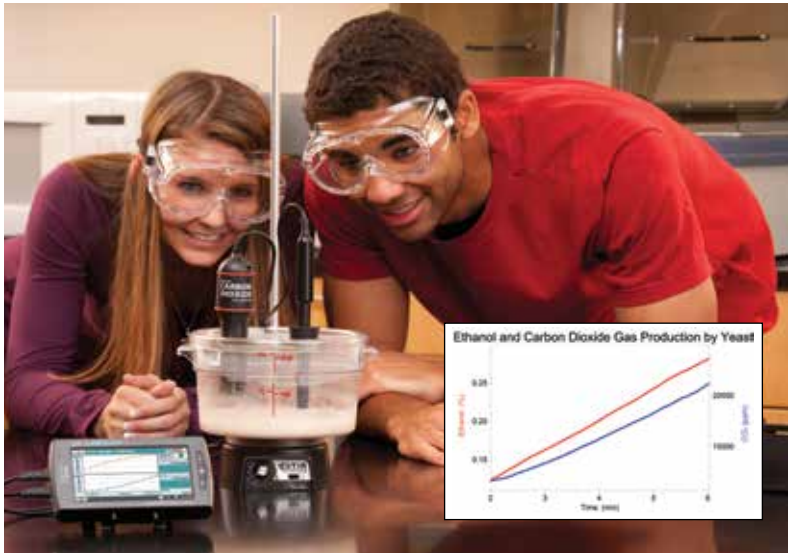
ORDER CODE **PAR-BTA**

The PAR (Photosynthetically Active Radiation) Sensor measures photosynthetic light levels in both air and water. It features a waterproof sensor head and can be used to measure Photosynthetic Photon Flux Density (PPFD) from sunlight and electric light sources. It is sensitive to visible light in the spectral range that is used by plants in photosynthesis (400–700 nm). This sensor is ideal for experiments investigating photosynthesis and primary productivity, and can also be used in many agricultural and environmental science applications.

d. BioChambers

2000 mL, ORDER CODE **BC-2000**
250 mL, ORDER CODE **BC-250**

BioChambers provide a way for both CO_2 Gas and O_2 Gas Sensors, or one of these along with the Ethanol Sensor, to be used at the same time in a closed system.



Measuring CO_2 gas and ethanol production during fermentation

Measuring photosynthetic light levels and dissolved oxygen concentration in a saltwater aquarium using the PAR Sensor and the Optical DO Probe

Using the Vernier Optical DO Probe to measure primary productivity

WHICH DO PROBE IS RIGHT FOR ME?

	Vernier Optical DO Probe	Dissolved Oxygen Probe
No calibration required	✔	
No stirring required	✔	
No warm-up time	✔	
No electrode filling solution	✔	
Automatic pressure compensation	✔	
Automatic temperature compensation	✔	✔
Measure in mg/L	✔	✔
Measure in % saturation	✔	
Works with LabQuest and LabQuest Mini	✔	✔
Works with Go!Link		✔
Order code	ODO-BTA	DO-BTA

Vernier Optical DO Probe

ORDER CODE **ODO-BTA**

a. Vernier Optical DO Probe, ORDER CODE ODO-BTA

Students can now measure the concentration of dissolved oxygen in water quickly and easily with the new Vernier Optical DO Probe. The Vernier Optical DO Probe uses luminescent technology to provide fast, easy, and accurate measurements of dissolved oxygen concentrations, making it a terrific choice for biology, ecology, or environmental science courses. This probe can be used to measure dissolved oxygen concentration in surface water or to perform a wide variety of experiments to determine changes in dissolved oxygen levels, one of the primary indicators of the quality of an aquatic environment.

- Plug-and-play technology—no filling solution, warm-up time, calibration, or stirring necessary
- Built-in temperature and pressure compensation
- Easy maintenance
- Switch setting allows units of mg/L or % saturation

ACCESSORIES

b. Optical DO Probe Metal Guard

ORDER CODE **ODO-GRD**

Attach the metal guard to the Vernier Optical DO Probe to protect the cap and to help weigh down the probe when submerged.

c. Optical DO Probe Replacement Cap*

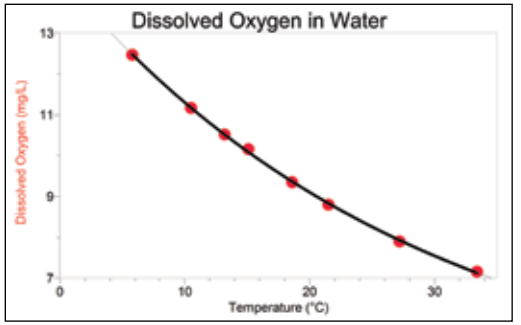
ORDER CODE **ODO-CAP**

The cap on the Vernier Optical DO Probe will need to be replaced every few years.

* Optical DO Probe caps are warranted to be free from defects for a period of twelve months from the date of purchase; it is possible that you may get somewhat longer use than the warranty period.

MORE ONLINE – For more information on the Vernier Optical DO Probe, visit **www.vernier.com/odo-bta**

a



Saturated dissolved oxygen at various temperatures

b

c

ProScope HR™

high resolution handheld microscope

High-Resolution Handheld Microscope

The ProScope HR is a USB handheld digital microscope designed for use with your computer. With a high-quality CMOS and universal lens mount, the ProScope HR can become a powerful addition to any classroom.

- Instantly displays digital images on a computer screen
- Takes still photos, movies, and time-lapse videos
- Interchangeable lenses make it easy to get the magnification you need
- Includes ProScope HR software and works with Logger *Pro*
- Lens-mounted, white LEDs make lighting subjects simple
- Lenses also sold separately on our web site at **www.vernier.com/proscope**

All ProScopes carry a two-year warranty.

ProScope HR

ORDER CODE **BD-HRB**

Get started capturing high-resolution microscopic images of hair follicles, the ridges and troughs of your finger prints, and more with the 50X lens.

Includes: ProScope HR Unit, ProScope HR Software, and 50X Lens.

Biology ProScope HR Kit

ORDER CODE **BD-HRBIOL**

Use the ProScope HR as a dissecting microscope or attach the ProScope HR to your regular microscope for even more magnification.

Includes: ProScope HR Unit, ProScope HR Software, 50X Lens, 1-10X Lens, C-Mount Adapter with IR Cut Filter, Microscope Lens Tube Adapter, Camera Stand, Rugged Hard-Side Case

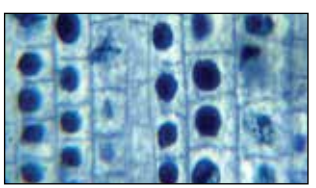
NEW ProScope Micro Mobile

For iPad: **BD-PMM-IPADK**
For iPad Air: **BD-PMM-IPAIRK**
For iPhone 4/4S: **BD-PMM-IP4K**
For iPhone 5: **BD-PMM-IP5K**

The ProScope Micro Mobile is the first professional-level microscope made for use with iPad, iPad mini, iPhone, IPod touch, and Android devices. For additional device options and more information, visit **www.vernier.com/bd-pmm**

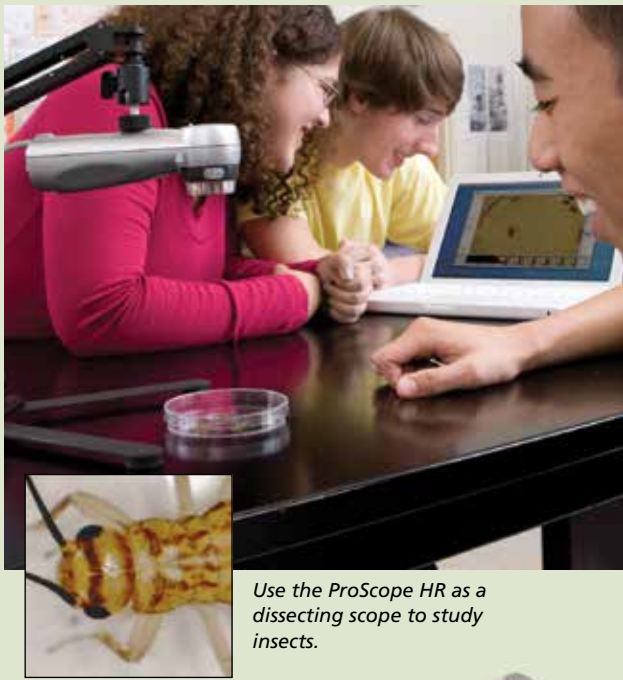
Aphid

Gel electrophoresis



Onion root tip

Lily pollen grain



Use the ProScope HR as a dissecting scope to study insects.

Connect the ProScope HR to a microscope for more powerful magnification.

Higher resolution ProScope HR2 model also available. For details visit ***www.vernier.com/proscope***

Experiment 6 from* Chemistry with Vernier, *"Boyle's Law"

CHEMISTRY

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1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest, computers, and TI graphing calculators.

Also recommended: *Investigating Chemistry through Inquiry* page 44.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

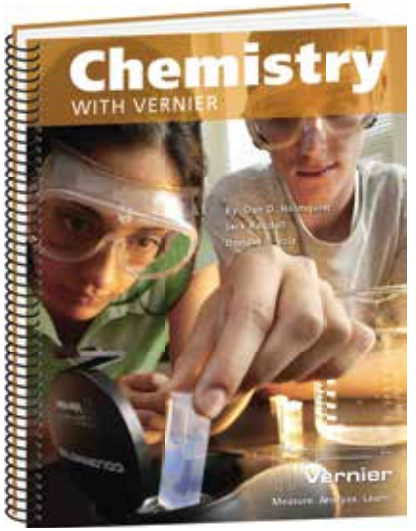
Our Deluxe Package contains all the sensors needed to perform every experiment in our chemistry lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



CHEMISTRY LAB BOOK

ORDER CODE **CWV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information, including instructions for preparing solutions
- 36 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate the labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/cwv**

Chemistry with Vernier lab book contains the following experiments:

USING TEMPERATURE PROBES
- Endothermic and Exothermic Reactions
- Freezing and Melting of Water
- Another Look at Freezing Temperature
- Heat of Fusion of Ice
- Pressure-Temperature Relationships
- Fractional Distillation
- Evaporation and Intermolecular Attractions
- Vapor Pressure of Liquids
- Effect of Temperature on Solubility
- Finding Molecular Weight
- Energy Content of Foods
- Energy Content of Fuels
- Hess's Law
- Heat of Combustion: Magnesium

USING A pH SENSOR
- Household Acids and Bases
- Acid Rain
- Titration Curves of Acids and Bases
- Acid-Base Titration
- Titration of a Diprotic Acid
- Acid Dissociation Constant, K_a
- Time-Released Vitamin C Tablet
- The Buffer in Lemonade
- Phosphoric Acid Content in Soft Drinks
- Microscale Acid-Base Titration

USING A VOLTAGE PROBE
- Micro-Voltaic Cells
- Lead Storage Batteries

USING A GAS PRESSURE SENSOR
- Boyle's Law: Gas Pressure and Volume
- Pressure-Temperature Relationship
- Vapor Pressure of Liquids

USING A COLORIMETER
- Beer's Law
- Finding an Equilibrium Constant, K_c
- Rate Law Determination of the Crystal Violet Reaction
- Chlorine Content of Swimming Pool Water
- Quantity of Iron in a Vitamin Tablet

USING A CONDUCTIVITY PROBE
- Electrolytes and Non-Electrolytes
- The Effect of Concentration
- Using Conductivity to Find an Equivalence Point

USING A DROP COUNTER *(optional)*
- Acid-Base Titration
- Titration of a Diprotic Acid
- Using Conductivity to Find an Equivalence Point

USING NO SENSOR
- Find the Relationship: An Exercise in Graphical Analysis

STARTER PACKAGES DELUXE PACKAGES VIDEO ONLINE

Chemistry LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-CH-ST	Deluxe Package LQ2-CH-DX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
pH Sensor	PH-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
Conductivity Probe	CON-BTA		✔
Colorimeter	COL-BTA		✔
Drop Counter	VDC-BTD		✔

YOU MAY ALSO NEED:

***Chemistry with Vernier* lab book,** ORDER CODE **CWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

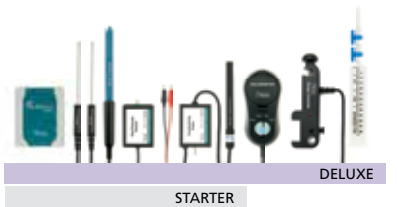
LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 CHEMISTRY PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-CH-ST	Deluxe Package LM-CH-DX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
pH Sensor	PH-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
Conductivity Probe	CON-BTA		✔
Colorimeter	COL-BTA		✔
Drop Counter	VDC-BTD		✔



YOU MAY ALSO NEED:

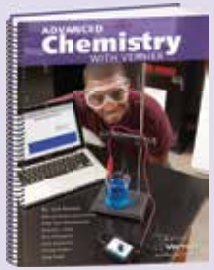
***Chemistry with Vernier* lab book,** ORDER CODE **CWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI CHEMISTRY PACKAGES

Also recommended: *Investigating Chemistry through Inquiry* lab book. See page 44.

WE ALSO RECOMMEND:



Advanced Chemistry with Vernier **lab book**

ORDER CODE
CHEM-A

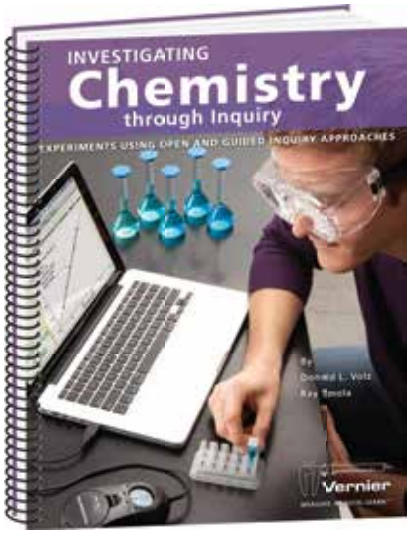
This book contains 35 advanced chemistry experiments designed for use with Vernier probeware.

AP* CHEMISTRY TEACHERS

The AP Chemistry Course Description recommends that teachers engage their students in at least 16 lab experiments, six of which need to be guided inquiry. Many of the experiments in the *Advanced Chemistry with Vernier* and the *Investigating Chemistry through Inquiry* lab books align well with the AP Chemistry Framework. These experiments are indicated by the letters "AP" in parentheses after the lab titles. We recommend that AP Chemistry teachers purchase both of these books. For a complete correlation of Vernier labs with AP Chemistry lab objectives, visit **www.vernier.com/ap**

IB† CHEMISTRY TEACHERS

The International Baccalaureate program has a complete set of objectives for an IB Chemistry class at the standard level (SL) and the higher level (HL). Many of the experiments in the *Investigating Chemistry through Inquiry* and *Advanced Chemistry with Vernier* lab books would fit perfectly. We recommend that IB Chemistry teachers purchase both of these books. For a complete correlation of Vernier labs with IB Chemistry lab objectives, visit **www.vernier.com/ib**



CHEMISTRY INQUIRY LAB BOOK

ORDER CODE **CHEM-I** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- 25 inquiry-based, chemistry investigations
- Essential teacher information for successful inquiry investigations
- Suggested researchable questions, sample data, and graphs
- A generous site license—buy one book and duplicate the labs for your class
- Microsoft® Word® files on CD for the experiments so you can easily edit labs to meet your personal teaching style

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/chem-i**

Investigating Chemistry through Inquiry lab book contains the following investigations:

USING A TEMPERATURE PROBE
- Physical Properties of Water
- Baking Soda and Vinegar Investigations
- An Investigation of Urea-Containing Cold Packs **(AP)**
- Identifying a Pure Substance **(AP)**
- Investigating the Energy Content of Foods
- Investigating the Energy Content of Fuels
- Evaporation and Intermolecular Attractions
- Enthalpy Changes
- Reaction Stoichiometry
- Colligative Properties of Solutions
- Long Term Water Monitoring
- Vapor Pressure and Heat of Vaporization Investigations
- The Effect of Acid Deposition on Aqueous Systems **(AP)**
- Baking Soda and Vinegar Investigations Revisited **(AP)**
- Reaction Rates **(AP)**
- Enzyme Activity
- Sugar Fermentation by Yeast

USING A GAS PRESSURE SENSOR
- Vapor Pressure and Heat of Vaporization Investigations
- Baking Soda and Vinegar Investigations Revisited **(AP)**
- Reaction Rates **(AP)**
- Enzyme Activity
- Sugar Fermentation by Yeast

USING A pH SENSOR
- Long Term Water Monitoring
- Acid-Base Properties of Household Products **(AP)**
- The Effect of Acid Deposition on Aqueous Systems **(AP)**
- Acid-Base Titrations **(AP)**
- Baking Soda and Vinegar Investigations Revisited **(AP)**

USING A VOLTAGE PROBE
- Investigating Voltaic Cells

USING A CONDUCTIVITY SENSOR
- Conductivity of Aqueous Solutions **(AP)**
- Long Term Water Monitoring
- Conductimetric Titrations

USING A COLORIMETER OR SPECTROVIS PLUS
- Beer's Law Investigations **(AP)**

USING AN ORP SENSOR
- Oxidation-Reduction Titrations **(AP)**

USING A RADIATION MONITOR
- Nuclear Radiation

VIDEO ONLINE

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†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Chemistry Inquiry LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS		CODE	Colorimeter Deluxe **LQ2-CMI-DX**	SpectroVis Plus Deluxe **LQ2-CMI-SV**
Vernier LabQuest 2 Interface		**LABQ2**	✔	✔
Stainless Steel Temperature Probe		TMP-BTA	✔	✔
pH Sensor		PH-BTA	✔	✔
Gas Pressure Sensor		GPS-BTA	✔	✔
Conductivity Probe		CON-BTA	✔	✔
Drop Counter		VDC-BTD	✔	✔
ORP Sensor		ORP-BTA	✔	✔
CHOOSE ONE	**Colorimeter** or	COL-BTA	✔	—
	SpectroVis Plus Spectrophotometer	SVIS-PL	—	✔

COLORIMETER DELUXE

SPECTROVIS PLUS DELUXE

YOU MAY ALSO NEED:

Investigating Chemistry through Inquiry **lab book** ORDER CODE **CHEM-I**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW** See page 17.

LABQUEST 2 | CHEMISTRY INQUIRY COLORIMETER PACKAGE | CHEMISTRY INQUIRY SPECTROVIS PLUS PACKAGE

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS		CODE	Colorimeter Deluxe **LM-CMI-DX**	SpectroVis Plus Deluxe **LM-CMI-SV**
Vernier LabQuest Mini Interface		**LQ-MINI**	✔	✔
Stainless Steel Temperature Probe		TMP-BTA	✔	✔
pH Sensor		PH-BTA	✔	✔
Gas Pressure Sensor		GPS-BTA	✔	✔
Conductivity Probe		CON-BTA	✔	✔
Drop Counter		VDC-BTD	✔	✔
ORP Sensor		ORP-BTA	✔	✔
CHOOSE ONE	**Colorimeter** or	COL-BTA	✔	—
	SpectroVis Plus Spectrophotometer	SVIS-PL	—	✔

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SPECTROVIS PLUS DELUXE

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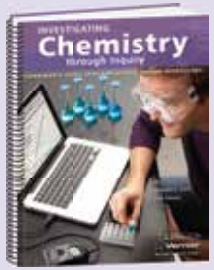
Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI | CHEMISTRY INQUIRY COLORIMETER PACKAGE | CHEMISTRY INQUIRY SPECTROVIS PLUS PACKAGE

STARTER PACKAGES for chemistry inquiry are available online at www.vernier.com/packages/inquiry-chemistry

WE ALSO RECOMMEND:



***Investigating Chemistry through Inquiry* lab book**

ORDER CODE
CHEM-I

This lab book, reviewed and recommended by NSTA, contains 25 inquiry-based chemistry investigations. If you are new to inquiry-based instruction, the extensive teacher section will help guide you through the inquiry-based style of chemistry instruction. See page 44.

AP* CHEMISTRY TEACHERS

The AP Chemistry Course Description recommends that teachers engage their students in at least 16 lab experiments, six of which need to be guided inquiry. Many of the experiments in the *Advanced Chemistry with Vernier* and the *Investigating Chemistry through Inquiry* lab books align well with the AP Chemistry Framework. These experiments are indicated by the letters "AP" in parentheses after the lab titles. We recommend that AP Chemistry teachers purchase both of these books. For a complete correlation of Vernier labs with AP Chemistry lab objectives, visit **www.vernier.com/ap**

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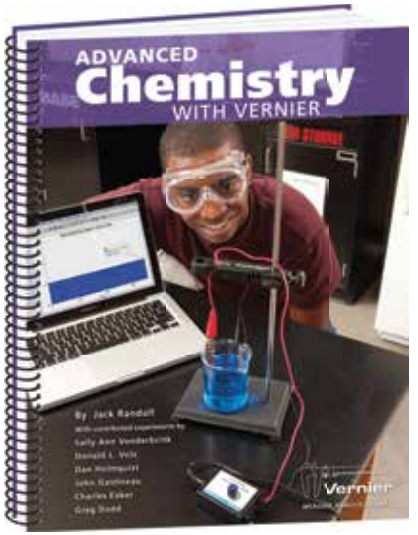

ADVANCED CHEMISTRY LAB BOOK

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Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information, including instructions for preparing solutions
- 35 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate the labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/chem-a**

Advanced Chemistry with Vernier lab book contains the following experiments:

USING TEMPERATURE PROBES
- Using Freezing-Point Depression to Find Molecular Weight
- The Molecular Mass of a Volatile Liquid
- Molar Volume of a Gas **(AP)**
- Vapor Pressure and Heat of Vaporization
- Rate Determination and Activation Energy
- Synthesis and Analysis of Aspirin **(AP)**
- Exploring the Properties of Gases
- Determining the Mole Ratios in a Chemical Reaction
- Determining the Enthalpy of a Chemical Reaction
- Synthesis and Analysis of Alum
- The Enthalpy of Neutralization of Phosphoric Acid

USING A pH SENSOR
- Standardizing a Solution of Sodium Hydroxide
- Buffers **(AP)**
- Determining the K_{sp} of Calcium Hydroxide
- Determining K_a by the Half Titration of a Weak Acid

USING A COLORIMETER OR SPECTROVIS PLUS
- The Determination of an Equilibrium Constant **(AP)**
- Determining the Concentration of a Solution: Beer's Law **(AP)**
- The Rate and Order of a Chemical Reaction
- The Synthesis and Analysis of Aspirin **(AP)**
- Rate Determination and Activation Energy

USING A pH SENSOR AND DROP COUNTER
- Acid-Base Titration **(AP)**
- Investigating Indicators

USING A VOLTAGE PROBE
- Electrochemistry: Voltaic Cells

USING A GAS PRESSURE SENSOR
- The Decomposition of Hydrogen Peroxide **(AP)**
- The Molar Volume of a Gas **(AP)**
- Exploring the Properties of Gases
- Vapor Pressure and Heat of Vaporization

USING A CONDUCTIVITY PROBE & DROP COUNTER
- Conductimetric Titration and Gravimetric Determination
- The Base Hydrolysis of Ethyl Acetate

USING AN ORP SENSOR & DROP COUNTER
- An Oxidation-Reduction Titration: Fe^{2+} and Ce^{4+} **(AP)**
- Potentiometric Titration of Hydrogen Peroxide **(AP)**

CONSTANT CURRENT SYSTEM
- Electroplating
- Avogadro's Number

USING A RADIATION MONITOR
- Alpha, Beta, and Gamma
- Radiation Shielding
- Half-Life Determination

NO SENSOR USED
- The Determination of a Chemical Formula **(AP)**
- The Determination of the Percent Water in a Compound **(AP)**
- Separation and Qualitative Analysis of Cations **(AP)**
- Liquid Chromatography **(AP)**

VIDEO ONLINE

Advanced Chemistry LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS		CODE	Colorimeter Deluxe **LQ2-CHMA-DLX**	SpectroVis Plus Deluxe **LQ2-CHMA-SV**
Vernier LabQuest 2 Interface		**LABQ2**	✔	✔
Stainless Steel Temperature Probe		TMP-BTA	✔	✔
pH Sensor		PH-BTA	✔	✔
Gas Pressure Sensor		GPS-BTA	✔	✔
Voltage Probe		VP-BTA	✔	✔
Conductivity Probe		CON-BTA	✔	✔
Drop Counter		VDC-BTD	✔	✔
Constant Current System		CCS-BTA	✔	✔
ORP Sensor		ORP-BTA	✔	✔
CHOOSE ONE	**Colorimeter** or	COL-BTA	✔	—
	SpectroVis Plus Spectrophotometer	SVIS-PL	—	✔
LABQUEST 2		ADVANCED CHEMISTRY COLORIMETER PACKAGE		ADVANCED CHEMISTRY SPECTROVIS PLUS PACKAGE

COLORIMETER DELUXE

SPECTROVIS PLUS DELUXE

YOU MAY ALSO NEED:

Advanced Chemistry with Vernier **lab book**
ORDER CODE **CHEM-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS		CODE	Colorimeter Deluxe **LM-CHMA-DX**	SpectroVis Plus Deluxe **LM-ACSV-DX**
Vernier LabQuest Mini Interface		**LQ-MINI**	✔	✔
Stainless Steel Temperature Probe		TMP-BTA	✔	✔
pH Sensor		PH-BTA	✔	✔
Gas Pressure Sensor		GPS-BTA	✔	✔
Voltage Probe		VP-BTA	✔	✔
Conductivity Probe		CON-BTA	✔	✔
Drop Counter		VDC-BTD	✔	✔
Constant Current System		CCS-BTA	✔	✔
ORP Sensor		ORP-BTA	✔	✔
CHOOSE ONE	**Colorimeter** or	COL-BTA	✔	—
	SpectroVis Plus Spectrophotometer	SVIS-PL	—	✔
LABQUEST MINI		ADVANCED CHEMISTRY COLORIMETER PACKAGE		ADVANCED CHEMISTRY SPECTROVIS PLUS PACKAGE

COLORIMETER DELUXE

SPECTROVIS PLUS DELUXE

YOU MAY ALSO NEED:

Advanced Chemistry with Vernier **lab book**
ORDER CODE **CHEM-A**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

STARTER PACKAGES for advanced chemistry are available online at www.vernier.com/packages/advanced-chemistry

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. These are Microsoft Word files, so you can edit them for your own organic chemistry lab manual.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

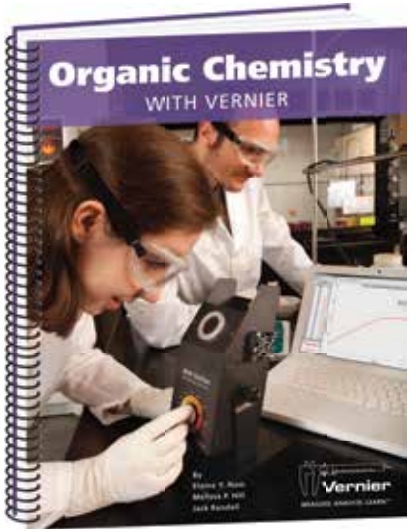
Choose from Vernier's recommended list of sensors for organic chemistry.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



ORGANIC CHEMISTRY LAB BOOK

ORDER CODE **CHEM-O** GREAT VALUE!

This college-level book makes it easy for organic chemistry instructors to integrate Vernier data-collection technology into the organic chemistry lab curriculum. When you buy the lab book you will receive

- Complete student experiments with materials list, step-by-step instructions, data tables, and questions
- Instructor Information section for each experiment with directions for setting up experiments, helpful hints, and sample graphs and data
- Word-processing files of the student pages on a CD so that any experiment may be easily edited to your specifications (Microsoft® Word® for Macintosh and Windows files)
- Generous site license—buy one book and duplicate experiments for your class
- Includes equipment and chemicals list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/chem-o**

Organic Chemistry with Vernier lab book contains the following experiments:

USING A MELT STATION
- Determining Melting Temperature
- Recrystallization of Benzoic Acid and Aspirin
- Identifying an Unknown Analgesic by Melting Temperature and Thin-Layer Chromatography
- Separation of Organic Compounds by Acid-Base Extraction Techniques
- The Synthesis and Analysis of Aspirin
- Synthesis of Dibenzalacetone by Aldol Condensation
- The Diels-Alder Reaction of Anthracene with Maleic Anhydride
- Friedel-Crafts Acylation of Ferrocene

USING A MINI GAS CHROMATOGRAPH
- Fractional Distillation of Esters
- Investigating Gas Chromatography
- Understanding Intermolecular Forces Using a Gas Chromatograph: Enthalpy of Vaporization
- Investigating Thermodynamic Relationships of Substituted Hydrocarbons
- Synthesizing Ethyl Acetate by Fisher Esterification
- Using a Gas Chromatograph: Identifying an Unknown Compound
- S_N1: Synthesis of t-butyl chloride
- S_N2: Synthesis of 1-bromobutane

USING A SPECTROVIS PLUS
- Extraction of Spinach Pigments and Analysis by Electronic Absorption Spectroscopy
- The Synthesis and Analysis of Aspirin
- Grignard Formation of Crystal Violet
- Synthesis of Fluorescein
- Synthesis of Methyl Orange and Its Application to Textiles

USING A POLARIMETER
- Understanding Polarimetry
- Identification of Organic Unknowns Using Polarimetry
- Observing the Reaction Kinetics of Sucrose with Polarimetry
- Isolation and Epoxidation of a Natural Product: Limonene
- Analysis of Natural Products

USING A WIDE-RANGE TEMPERATURE PROBE
- Determination of a Boiling Point: Simple and Fractional Distillation
- Fractional Distillation of Esters
- The Synthesis and Analysis of Aspirin
- Isolation and Epoxidation of a Natural Product: Limonene
- Synthesis of Dibenzalacetone by Aldol Condensation
- The Diels-Alder Reaction of Anthracene with Maleic Anhydride
- Friedel-Crafts Acylation of Ferrocene
- Synthesis of Fluorescein

Products for Organic Chemistry

LabQuest 2 or LabQuest Mini

LABQUEST 2
CONNECTED SCIENCE SYSTEM

Standalone, Computer, or Tablet

Computer Only

INTERFACE & SENSORS		CODE	LABQUEST 2	LABQUEST MINI
CHOOSE ONE	**LabQuest 2**	**LABQ2**	✔	—
	LabQuest Mini (computer)	**LQ-MINI**	—	✔
Wide-Range Temperature Probe		WRT-BTA	✔	✔
Melt Station		MLT-BTA	✔	✔
Polarimeter (Chemical)		CHEM-POL	✔	✔
SpectroVis Plus (VIS-NIR spectrometer)		SVIS-PL	✔	✔
Mini GC Plus		GC2-MINI	✔	✔

LABQUEST 2
LABQUEST MINI

YOU MAY ALSO NEED:

Organic Chemistry with Vernier **lab book**
ORDER CODE **CHEM-O**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

Mini GC Plus chromatogram of a ketone mixture

VERNIER MINI GC® PLUS ORDER CODE GC2-MINI

The Mini GC Plus gas chromatograph is a portable instrument for separating, analyzing, and identifying substances contained in a volatile liquid or gaseous sample. Key features include

- Expanded library of organic compounds including halogenated hydrocarbons, nitroalkanes, amides, and more
- Increased maximum temperature of 160°C
- Uses room air as the carrier gas

Each Mini GC Plus includes a lab book, featuring five experiments suitable for high school or college organic chemistry and is covered by a two-year warranty (syringe, column, sensor, and septa excluded).

Accessories

GC Septa (pkg 4), ORDER CODE **GC-SEP**
GC Syringe, 1 µL Hamilton, ORDER CODE **GC-SYR-MIC**

MORE ONLINE – For more information about the Mini GC Plus, visit **www.vernier.com/gc2-mini**
See training video at **www.vernier.com/videos**

Chemical Polarimeter

ORDER CODE **CHEM-POL**

The Chemical Polarimeter is a device used for measuring the rotation of plane-polarized light caused by an optically active substance without chemically modifying or destroying the sample. This is a vertical polarimeter that uses an integrated 589 nm LED, a fixed polarizer, and a manually rotated polarizer to detect changes in rotation of plane-polarized light.

- Light and angle sensors log light transmission *versus* angle over 360° of rotation.
- Digital optical encoder and analysis tools (in Logger *Pro* computer software and LabQuest) enable determination of specific rotation to ±1°.
- Includes custom sample cell with pour spout and height scale.
- Powered by computer (interface required) or LabQuest—no power cord!

MORE ONLINE – Downloadable experiments are available for free online at **www.vernier.com/chem-pol**

Melt Station

Melting Temperature Sensor

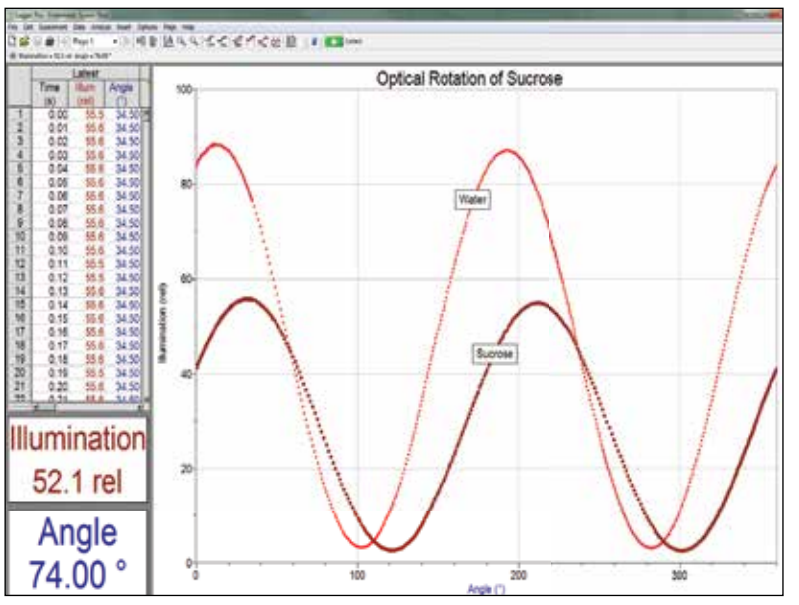
ORDER CODE **MLT-BTA**

Our Melt Station connects to LabQuest, LabQuest Mini, Go!Link, or LabPro. Use it to measure the melting temperature of solid substances.

- Accurate results using a built-in RTD sensor over a range of 30°C to 260°C
- High-quality 6X viewing lens for clear observation of the samples
- Innovative, adjustable tilt allows for optimal viewing angle
- Cooling fan reduces time between tests

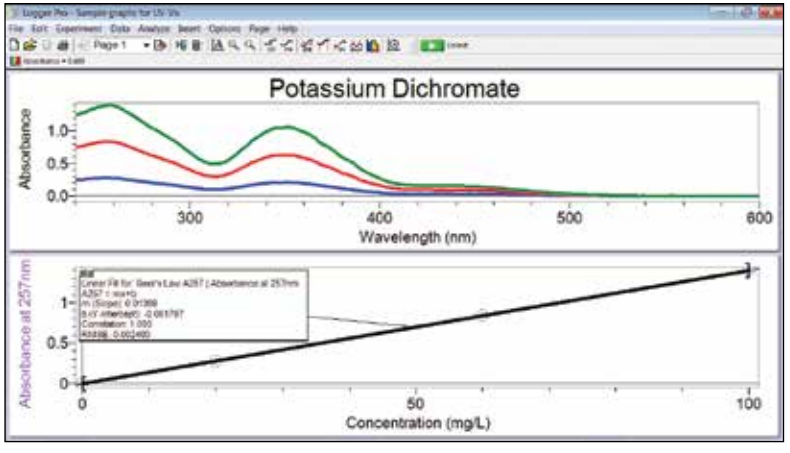
MORE ONLINE – www.vernier.com/mlt-bta

Analyzing the optical rotation of sucrose using the Polarimeter and LabQuest 2



Logger Pro *allows easy detection of the optical rotation of compounds like sucrose*

Examining the absorbance spectrum of potassium dichromate using the Vernier UV-VIS Spectrophotometer and LabQuest 2



Beer's law plot of potassium dichromate

NEW Vernier UV-VIS Spectrophotometer

ORDER CODE **VSP-UV**

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer appropriate for advanced high school, college, and graduate level education. It is an easy and accurate instrument ideal for measuring the absorbance spectra of various chemical and biochemical compounds and rates of reactions. As a USB device, it plugs directly into your computer or LabQuest. Appropriate for advanced high school, college, and graduate level education.

PRODUCT SPECIFICATIONS

Wavelength Range: 220-850 nm
Wavelength Reporting Interval: ~1 nm
Wavelength Accuracy†: ±2.0 nm
Photometric Accuracy‡: ±5.0%
Light Source: deuterium (UV) and incandescent (VIS)
Dimensions: 18.5 cm x 17.0 cm x 7.0 cm

† As determined with holmium oxide NIST standard
‡ As determined with potassium dichromate NIST standards

WHAT'S INCLUDED

Spectrophotometer, AC power supply, two Starna quartz cuvettes, USB cable, and user manual

ACCESSORY

Quartz Cuvettes, package of two
(ORDER CODE **CUV-QUARTZ**)

MORE ONLINE – Downloadable experiments are available for free online at **www.vernier.com/vsp-uv**

Quartz Cuvettes

Spectrometer Accessories

CUVETTES

Plastic Cuvettes package of 100 (visible range)
ORDER CODE **CUV**
(Use with Vernier Spectrometer and SpectroVis Plus)

Quartz Cuvettes package of two
ORDER CODE **CUV-QUARTZ**
(Use with Vernier UV-VIS)

Cuvette Rack
ORDER CODE **CUV-RACK**

OPTICAL FIBERS

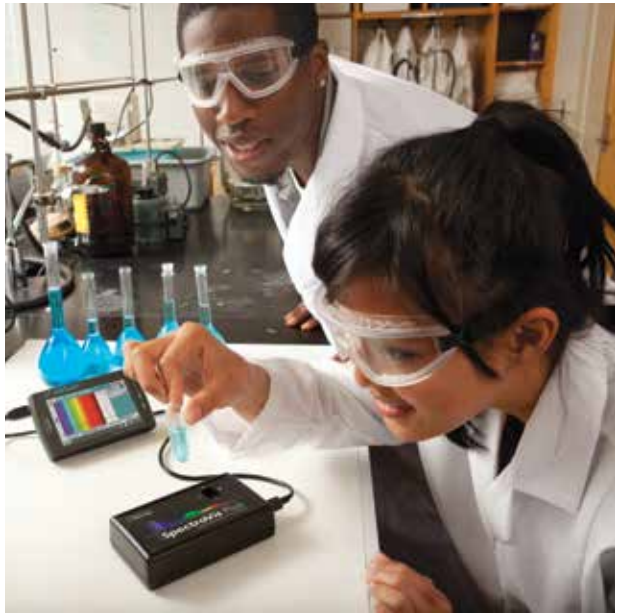
Optical fibers for spectrometers are available online at **www.vernier.com/spectrometers**

For more information on the Vernier Emissions Spectrometer, see page 91.

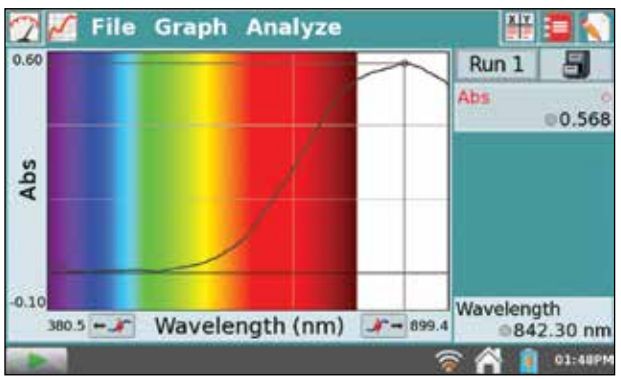
Spectrometers

	SpectroVis Plus	Vernier Spectrometer (Ocean Optics powered)	Vernier UV-VIS
Specs	• Wavelength range: 380–900 nm • Wavelength accuracy: ±7.0 nm (450 nm) ±3.0 nm (650 nm) • VIS-NIR • 1 nm between reported values	• Wavelength range: 380–950 nm • Wavelength accuracy: ±2.0 nm • VIS-NIR • 2 nm between reported values	• Wavelength range: 220–850 nm • Wavelength accuracy: ±2.0 nm • UV-VIS • 1 nm between reported values
Light Source & Sample Holder	Integrated sample holder and LED-boosted tungsten source. The sample holder takes standard 1 cm cuvettes. Additional LEDs allow for fluorescence spectra with excitation at 405 and 500 nm.	Combination sample holder and LED-boosted tungsten source. The sample holder takes standard 1 cm cuvettes.	Integrated sample holder with deuterium (UV) and tungsten (VIS) light source. The sample holder takes standard 1 cm cuvettes.
Items Included*	• Spectrophotometer • 15 plastic cuvettes with lids • USB cable • Connects by USB to a computer or LabQuest interface; no additional power source needed	• Spectrophotometer • Light source and cuvette holder • 15 plastic cuvettes with lids • USB cable • Connects by USB to a computer or LabQuest interface; no additional power source needed	• Spectrophotometer • Two Starna quartz cuvettes • USB cable • AC power supply • Connects by USB to a computer or LabQuest interface
Warranty	5 years (3 years light source)	3 years (1 year light source)	5 years (1 year light source)
Order Code	**SVIS-PL***	**V-SPEC***	**VSP-UV***

* Software needed: Logger *Pro* or LabQuest App



Examining the absorbance spectrum of copper (II) sulfate using SpectroVis Plus and LabQuest 2



Spectrum of copper (II) sulfate

SpectroVis® Plus

ORDER CODE **SVIS-PL**

An Affordable Spectrophotometer and Fluorometer

Having a CCD array spectrometer/fluorometer combination is now affordable for each of your lab stations! Array spectrometer technology allows you to collect a full wavelength spectrum (absorbance, percent transmittance, or intensity) in less than one second. Once the peak wavelength is determined, you can easily determine the concentration of a solution (Beer's law) or monitor rates of reaction.

PRODUCT SPECIFICATIONS

Wavelength Range: 380–900 nm (VIS-NIR)
Wavelength Reporting Internal: ~1 nm
Wavelength Accuracy†: ±7.0 nm (450 nm), ±3.0 nm (650 nm)
Photometric Accuracy‡: ±13%
Light Source: Incandescent LEDs
Fluorescence: Two excitation sources centered at 405 nm and 500 nm
Dimensions: 15 cm x 9 cm x 4 cm

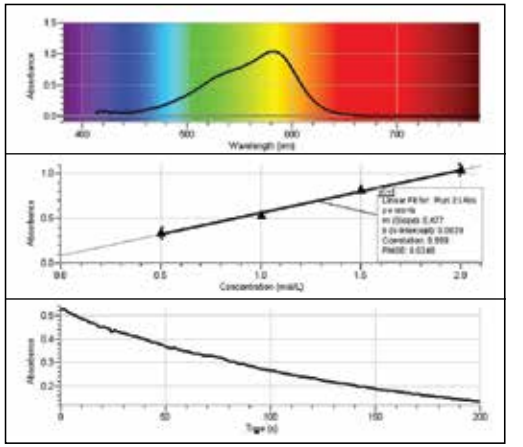
† As determined with holmium oxide NIST standard
‡ As determined with nickel sulfate NIST standards

FEATURES

- Collect a full spectrum in less than 1 second
- Easy one-step calibration
- Connects directly to LabQuest or to a computer's USB port
- No external power required
- Use the Optical Fiber (sold separately) to measure light emissions of LEDs, fluorescent bulbs, or incandescent lights. For spectrum tube emissions, we recommend the Vernier Emissions Spectrometer on page 91.

WHICH SPECTROMETER IS RIGHT FOR YOU?

It is important to keep in mind all the applications for which you might want to use your spectrometer. We offer spectrometers that measure absorbance, fluorescence, and/or emissions with varying degrees of resolution. To help you decide which one is right for you, see our Spectrometer Comparison Graphs at **www.vernier.com/spectracomparison**



Absorbance spectrum of crystal violet

a. Ohaus Scout™ Pro Balances

It is easy to collect mass data from an Ohaus Scout Pro balance using our popular Logger *Pro* 3 software. Simply connect a Scout Pro balance to your computer's USB or serial port, start the Logger *Pro* software, and collect real-time data as if the Ohaus balance was just another Vernier sensor!

Scout Pro 0.01 g balance (200 g) ORDER CODE **OHSP-202**
Scout Pro 0.01 g balance (400 g) ORDER CODE **OHSP-402**
Scout Pro 0.001 g balance (120 g) ORDER CODE **OHSP-123**

All three balances require:
Scout Pro USB connection kit ORDER CODE **OHSP-USB**

b. Instrumentation Amplifier, ORDER CODE INA-BTA

The Instrumentation Amplifier monitors voltages from 20 mV to 1 full scale V (DC or AC). It has several switch settings to allow you to select the best gain. It is typically used to amplify the chart recorder or analog output of any instrument, such as a gas chromatograph.

c. Ion-Selective Electrodes

Great for monitoring five environmentally important ions: Nitrate (NO_3^-), Chloride (Cl^-), Potassium (K^+), Calcium (Ca^{2+}), and Ammonium (NH_4^+). More on page 134.

Nitrate ISE
ORDER CODE **NO3-BTA**

Chloride ISE
ORDER CODE **CL-BTA**

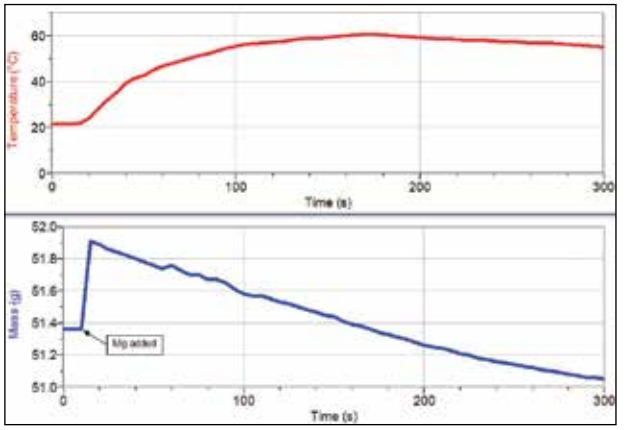
NEW Potassium ISE
ORDER CODE **K-BTA**

Calcium ISE
ORDER CODE **CA-BTA**

Ammonium ISE
ORDER CODE **NH4-BTA**

NOTE: Ion-Selective Electrodes require good chemical technique and careful calibration to obtain accurate results. They are not recommended for middle school or elementary school students.

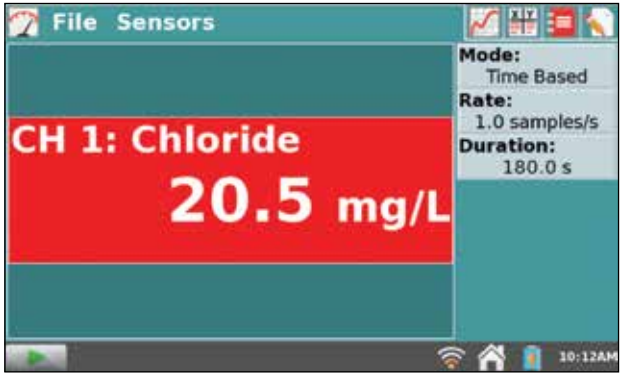
Nitrate, Potassium, Calcium, and Ammonium ISEs include modules carrying one-year warranties.



Monitoring temperature and mass in the HCl-Mg reaction

Vernier SOFTWARE & TECHNOLOGY & FLINN

Since 1995, Vernier has partnered with Flinn Scientific, the leading provider of chemistry education products, to provide outstanding support for AP Chemistry lab activities.



Testing the chloride ion concentration of pond water

Conducting an acid-base titration using a Vernier Drop Counter, pH Sensor, and Stir Station

Did you know?

You can use our Electrode Amplifier with third-party pH electrodes that have BNC connectors or purchase our BNC pH Electrode.

Electrode Amplifier
ORDER CODE **EA-BTA**

BNC pH Electrode*
ORDER CODE **7120B**

* Has a BNC connector to connect to EA-BTA (does not replace PH-BTA)

a. Constant Current System, ORDER CODE CCS-BTA

The Constant Current System is a DC power source capable of delivering up to 0.6 A with a built-in current probe designed for use in electrochemistry experiments. You can set the current by turning the dial with the system, automatically adjusting the voltage. Note: The Constant Current System works only with its own built-in power supply; it cannot be used to measure the current of a circuit using a different power supply.

For sample labs go to **www.vernier.com/ccs-bta**

b. Stir Station, ORDER CODE STIR

The Stir Station is a high-quality, multi-function magnetic stirrer. It has a stirring capacity of 800 mL in a 1 L beaker. It works efficiently with beakers with a volume as small as 50 mL and with a wide range of sizes and shapes of magnetic stirring bars. Includes Stir Station, Vernier Microstirrer (see page 149), magnetic stirring bar, AC power adapter, and removable ring-stand post. Can be used with AC power or 4 C batteries.

c. Electrode Support, ORDER CODE ESUP

The Electrode Support is a specialized utility clamp used to hold various Vernier sensors. The clamp end makes connecting to ring stands much easier, accommodating post diameters between 0.5 and 1 cm. Side grooves support the wire leads for electroplating or electrolysis experiments.

d. IMPROVED Vernier Drop Counter
ORDER CODE **VDC-BTD**

The improved Vernier Drop Counter allows your students to conduct titrations precisely, effectively, and hands free in less time. New features include

- Wide drop-detecting area
- Red LED, near the detecting area, flashes to indicate a drop has been recorded
- Accurate drop counting at rates up to 6 drops/second
- Adjustable clamp; fits most laboratory ring stands and lattices
- Large sensor slot; fits most conventional stick-style sensors
- Smaller, adjustable slot for temperature sensors

a

b

- *Three LEDs light up solutions*
- *Can be used with AC power or four C batteries*

c

d **IMPROVED**

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest, computers, and TI graphing calculators.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

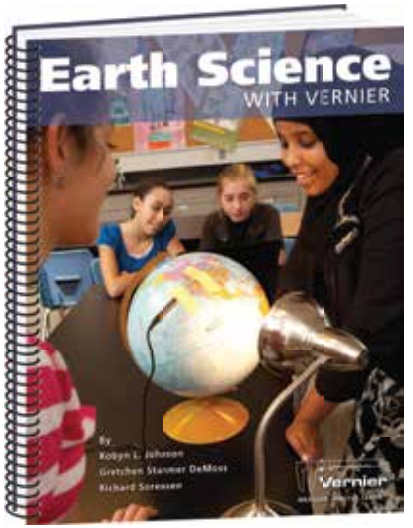
Our Deluxe Package contains all the sensors needed to perform every experiment in our Earth science lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



EARTH SCIENCE LAB BOOK

ORDER CODE **ESV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 33 ready-to-use student versions of Logger *Pro* experiments on hard copy. LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/esv**

Earth Science with Vernier lab book contains the following experiments:

USING A TEMPERATURE PROBE
- Introduction to Data Collection
- Soil Temperature
- Water Quality—Temperature
- Freezing of Ocean Water
- Reflection and Absorption of Light
- The Greenhouse Effect
- Land and Sea Breezes
- Relative Humidity
- Dew Point
- Wind Chill
- Seasons and Angle of Insolation
- Fossil Fuels
- Solar Homes

USING A LIGHT SENSOR
- Reflection and Absorption of Light
- Photovoltaic Cells

USING A pH SENSOR
- Soil pH
- Soil and Acid Rain
- Water Quality—pH
- Water Treatment
- Acid Rain and Its Effect on Surface Water

USING A MOTION DETECTOR
- Mapping the Ocean Floor

USING A UVB SENSOR
- Are All Sunglasses Created Equal?
- Comparing Sunscreens
- UV Light and Clothing

USING A CONDUCTIVITY PROBE
- Soil Salinity
- Water Quality—Total Dissolved Solids
- Water Treatment
- Salinity of Ocean Water
- Desalination

USING A TURBIDITY SENSOR
- Water Quality—Turbidity
- Water Treatment

USING A MAGNETIC FIELD SENSOR
- Exploring Magnetism
- Where IS North?
- Searching for Iron Ore
- Sea Floor Spreading

USING CURRENT AND VOLTAGE PROBES
- Photovoltaic Cells
- Wind Power

STARTER PACKAGES DELUXE PACKAGES VIDEO ONLINE

Look for training videos of some of these labs at **www.vernier.com/videos**

Earth Science LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-ES-ST	Deluxe Package LQ2-ES-DX
LabQuest 2 Interface	**LABQ2**	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
Light Sensor	LS-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
UVB Sensor	UVB-BTA	✔	✔
Magnetic Field Sensor	MG-BTA		✔
Conductivity Probe	CON-BTA		✔
Voltage Probe	VP-BTA		✔
Current Probe	DCP-BTA		✔
Turbidity Sensor	TRB-BTA		✔
Motion Detector	MD-BTD		✔

YOU MAY ALSO NEED:

***Earth Science with Vernier* lab book,** ORDER CODE **ESV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 EARTH SCIENCE PACKAGE

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-ES-ST	Deluxe Package LM-ES-DX
LabQuest Mini Interface	**LQ-MINI**	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
Light Sensor	LS-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
UVB Sensor	UVB-BTA	✔	✔
Magnetic Field Sensor	MG-BTA		✔
Conductivity Probe	CON-BTA		✔
Voltage Probe	VP-BTA		✔
Current Probe	DCP-BTA		✔
Turbidity Sensor	TRB-BTA		✔
Motion Detector	MD-BTD		✔

YOU MAY ALSO NEED:

***Earth Science with Vernier* lab book,** ORDER CODE **ESV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI EARTH SCIENCE PACKAGE

Davis Weather Stations

Because they are accurate, economical, easy to use, and well built, Davis Weather Stations are a perfect choice for your school. The Davis Vantage Vue™ weather station is rugged, accurate, reliable, and very affordable. If you want customizable, professional units, the Vantage Pro2 and Vantage Pro2 Plus are excellent choices. All versions are wireless.

For further information about Davis Weather Station products, including computer software and hardware mounting options, see **www.vernier.com/weather**

a. Vantage Vue™, ORDER CODE DWVUE

The Vantage Vue weather station includes a console with AC power adapter and a self contained, easy-to-install sensor system. The console displays current data along with the ability to view graphs. All without a computer!

The integrated sensor suite combines a rain collector, temperature sensor, humidity sensor, wind direction and anemometer—all in one package. Vantage Vue provides all of the following:

- Barometric pressure
- Rain rate
- Inside and outside humidity
- Rainfall totals
- Inside and outside temperature
- Wind chill
- Wind speed and direction
- Heat index
- Dew point
- Moon phase
- Local forecast
- Time of sunrise and sunset at your location
- Highs and lows for most weather variables

b. Vantage Pro2™, ORDER CODE DWVP

The Vantage Pro2 includes all of the features of Vantage Vue, however, you can add professional features such as a fan-aspirated radiation shield and other sensors.

Vantage Pro2 Plus™, ORDER CODE DWPLUS

The Vantage Pro2 Plus includes all of the features of Vantage Pro2, plus a UV sensor, solar radiation sensor, and a sensor mounting shelf. With the Solar Radiation Sensor, you can also measure evapo-transpiration, solar radiation intensity, and THSW (temperature/humidity/sun/wind) index. The UV Sensor provides UV dose and UV index.

Davis Vantage Vue Console/Receiver

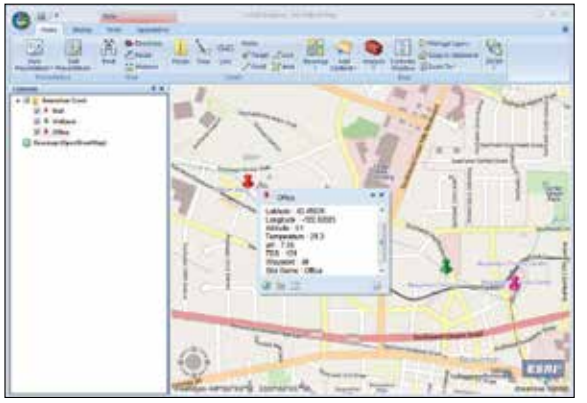
ORDER CODE **DWVUE-CR**

By purchasing additional Vantage Vue Console/Receivers, you can set up multiple monitoring stations in other classrooms throughout your school.

All Davis products carry a one-year warranty.

MAP YOUR DATA USING GIS SOFTWARE FROM ESRI

Map your Vernier data with ArcGIS Explorer, the free virtual globe from ESRI. ArcGIS Explorer can be downloaded at **www.esri.com/arcgisexplorer**

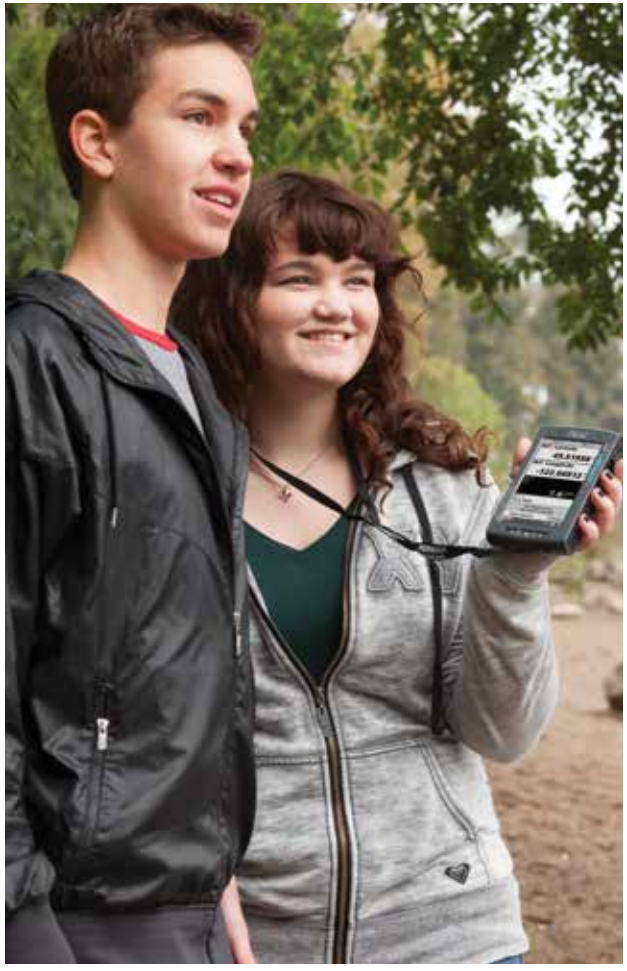


Water quality along Beaverton Creek mapped in ArcGIS Explorer

Anemometer

ORDER CODE **ANM-BTA**

The Vernier Anemometer is an impeller-type anemometer that measures wind speed in the range of 0.5 to 30 m/s (1 to 67 mph). The Anemometer fits in your palm for wind study measurements in the field. A standard camera mount on the back and an accessory rod allows you to position it in wind tunnels or in front of fans for wind turbine experiments.



a. Tris-Compatible Flat pH Sensor, ORDER CODE FPH-BTA

The Tris-Compatible Flat pH Sensor uses a double-junction electrode, making it compatible with Tris buffers and solutions containing proteins. The flat glass shape also makes it ideal for measuring the pH of semisolids, such as soft food or soil.

b. Magnetic Field Sensor, ORDER CODE MG-BTA

Study the magnetic field surrounding various types of magnets.

c. UVA and UVB Sensors

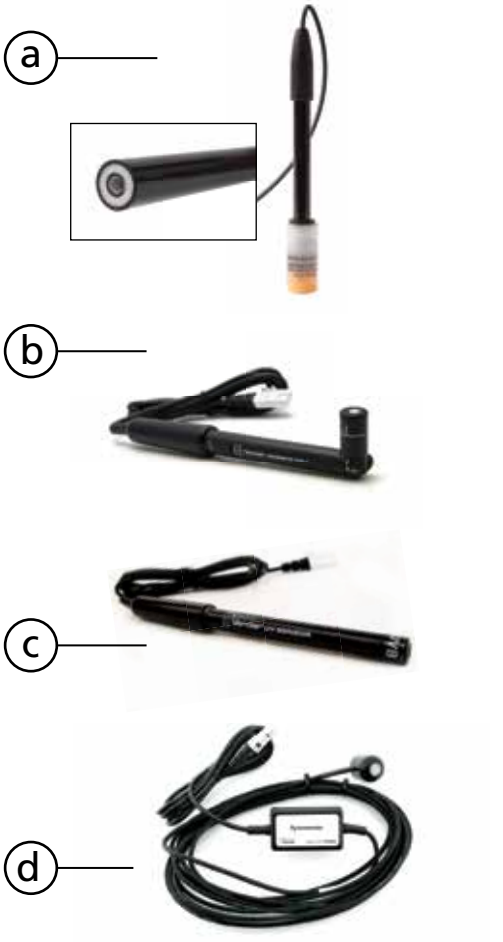
ORDER CODE UVA-BTA, UVB-BTA

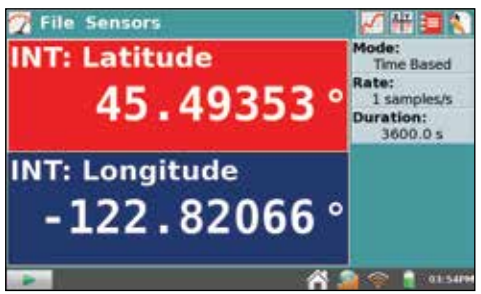
The UVA Sensor is an ultraviolet light sensor that responds primarily to UVA radiation (approximately 320 to 390 nm). This sensor is ideal for experiments using UV lamps.

The UVB Sensor is an ultraviolet light sensor that responds primarily to UVB radiation (approximately 290 to 320 nm). It is ideal for experiments using sunlight as your UV source and is the sensor recommended for the UV experiments in our lab books.

d. Pyranometer, ORDER CODE PYR-BTA

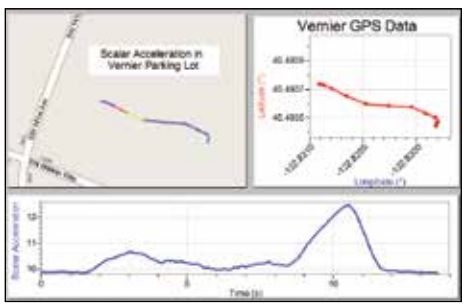
The Pyranometer measures the power of electromagnetic radiation. It is sensitive to near infrared, visible, and UV radiation, where 90% of solar energy is concentrated. It reads in watts per square meter, so it is great for experiments with solar cells and calculating their efficiency.



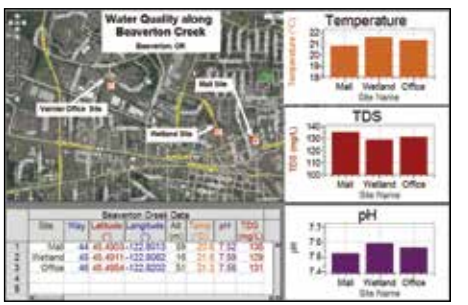


LabQuest showing latitude and longitude

LabQuest graphing the path of a bus ride in Tierra del Fuego



Visually mapping acceleration using Google Maps and Logger Pro



Logger Pro *combines GPS data and water quality sensor data*

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Our two *STEM with Vernier and LEGO MINDSTORMS NXT* lab books contain traditional science experiments, as well as design-and-build robotics projects.

2 ADD THE LEGO NXT INTERFACE & VERNIER NXT ADAPTER

Connect any one of 35 Vernier sensors to the LEGO NXT for science experiments and robotics projects using the Vernier NXT Sensor Adapter. See page 62.

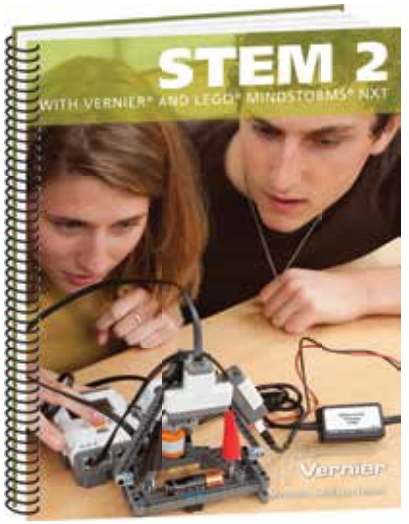
3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

Our STEM and STEM 2 packages contain all the sensors needed to perform every experiment in each lab book.

4 CHOOSE YOUR SOFTWARE

The STEM and STEM 2 lab books assume you are using LEGO MINDSTORMS NXT software. For advanced robotics projects, we recommend using National Instruments LabVIEW™ for Education software.



STEM 2 LAB BOOK

ORDER CODE **STEM2** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information
- 12 ready-to-use experiments
- 8 design-and-build robotics projects
- A generous site license—buy one book and duplicate labs for your class
- Microsoft® Word® files for all experiments on CD
- A CD with MINDSTORMS sample programs, movie clips, and LEGO Digital Designer files
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/stem2**

STEM 2 COVERS CORE TOPICS IN PHYSICAL SCIENCE

STEM 2 with Vernier and LEGO MINDSTORMS NXT lab book contains the following experiments and robotics projects:

USING A DIFFERENTIAL VOLTAGE PROBE
Experiments
- Batteries
- Lemon Battery
- Solar Cells

Projects
- Battery Tester
- Solar Tracker

USING A DUAL-RANGE FORCE SENSOR
Experiments
- Buoyancy
- First-Class Levers
- Friction
- Pulleys

Projects
- Audio Assistant
- String Tension Tester

USING A GAS PRESSURE SENSOR
Experiments
- Gas Pressure
- Grip Strength
- Yeast in Action

Project
- Cartesian Diver

USING A MAGNETIC FIELD SENSOR
Experiments
- Electromagnets
- Mapping a Magnetic Field

Projects
- Magnet Finder
- Migrating Robot
- Mine Sweeper

STEM 2 PHYSICAL SCIENCE PACKAGES VIDEO ONLINE Look for training videos of some of these labs at **www.vernier.com/videos**

Did you know? The STEM and STEM 2 lab books assume you are using the LEGO® MINDSTORMS® Education NXT Base Set and LEGO® MINDSTORMS® Education NXT Software version 2 or newer. Visit **education.lego.com** for more information.

Engineering LEGO NXT Packages

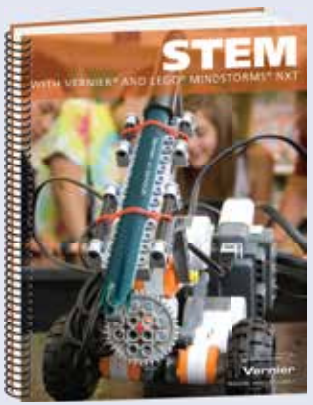
Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

NXT Sensor Adapter	NXT SENSOR ADAPTER & SENSORS	CODE	STEM 2 Physical Science Package NXT-PS	STEM Environmental Science Package NXT-EV
	Magnetic Field Sensor	MG-BTA	✔	
	Differential Voltage Probe	DVP-BTA	✔	
	Dual-Range Force Sensor	DFS-BTA	✔	
	Gas Pressure Sensor	GPS-BTA	✔	
	NXT Sensor Adapter	BTA-NXT	✔	✔✔
	Stainless Steel Temperature Probe	TMP-BTA		✔✔
	pH Sensor	PH-BTA		✔
	UVB Sensor	UVB-BTA		✔
	Conductivity Probe	CON-BTA		✔
	Soil Moisture Sensor	SMS-BTA		✔
NXT SENSOR ADAPTER	ENGINEERING LEGO NXT PHYSICAL SCIENCE PACKAGE			ENGINEERING LEGO NXT ENVIRONMENTAL SCIENCE PACKAGE

YOU MAY ALSO NEED:

One or both of our *STEM with Vernier* books
See below. ORDER CODE **STEM**
See previous page. ORDER CODE **STEM2**

LEGO MINDSTORMS NXT Kit
LEGO® MINDSTORMS® Education NXT Software



STEM COVERS CORE TOPICS IN ENVIRONMENTAL SCIENCE ORDER CODE STEM

STEM with Vernier and LEGO MINDSTORMS NXT lab book contains the following experiments and robotics projects:

☐ **USING A pH SENSOR**
Experiments
- Household Acids and Bases
- Acid Rain
- Soil pH and Water Absorption
- Water Quality
- A Water Field Study

Projects
- ▶ Acidity Tester
- ▶ Aquarium Monitor

☐ **USING A UVB SENSOR**
Experiments
- UV Light and Clothing
- UV Light and Sunglasses
- Comparing Sunscreens

Project
- ▶ Sunscreen Tester

☐ **USING A TEMPERATURE PROBE**
Experiments
- Heating of Land and Water
- Water Quality
- A Water Field Study
- A Good Sock

Project
- ▶ Aquarium Monitor

☐ **USING A CONDUCTIVITY PROBE**
Experiments
- Water Quality
- A Water Field Study
- Water Hardness
- Ocean Water

☐ **USING A SOIL MOISTURE SENSOR**
Experiments
- Soil Moisture
- Managing Garden Soil Moisture

Project
- ▶ Plant Waterer

☐ ENVIRONMENTAL SCIENCE PACKAGE ▶ VIDEO ONLINE

Look for training videos of some of these labs at **www.vernier.com/videos**

Robotics Videos

Cartesian Diver

This is a robot-controlled version of the classic science demonstration. A LEGO pneumatic pump and a valve are controlled by the robot to adjust pressure. The Vernier Gas Pressure Sensor is used to monitor the pressure.

Solar Tracker

The NXT monitors the output from two solar panels using the Vernier Differential Voltage Probe. The solar panels are mounted on a rotating platform. The robot rotates the platform toward the solar panel with the most light. The net result is that the solar panels follow the sun.

Audio Assistant

This project challenges the students to write a program to indicate the Dual-Range Force Sensor reading with a sound, rather than a number or a graph. The frequency of the sound produced by the NXT is related to the force.

Migrating Robot

This robot uses a Vernier Magnetic Field Sensor to detect the Earth's magnetic field and find north. It then migrates north, much like many animals do in the spring.

Many other robotics videos available at **www.vernier.com/nxt-videos**

SENSORS COMPATIBLE WITH NXT SENSOR ADAPTER

SENSOR	CODE	SENSOR	CODE
Accelerometers		Instrumentation Amplifier	INA-BTA
25-g Accelerometer	ACC-BTA	Light Sensor	LS-BTA
Low-g Accelerometer	LGA-BTA	Magnetic Field Sensor	MG-BTA
Anemometer	ANM-BTA	O_2 Gas Sensor	O2-BTA
Barometer	BAR-BTA	ORP Sensor	ORP-BTA
Charge Sensor	CRG-BTA	pH Sensor	PH-BTA
Colorimeter	COL-BTA	Relative Humidity Sensor	RH-BTA
Conductivity Probe	CON-BTA	Respiration Monitor Belt *(Requires GPS-BTA)*	RMB
Current Probes		Salinity Sensor	SAL-BTA
Current Probe	DCP-BTA	Soil Moisture Sensor	SMS-BTA
High Current Probe	HCS-BTA	Sound Level Meter	SLM-BTA
Differential Voltage Probe	DVP-BTA	Temperature Sensors	
Dissolved Oxygen Probe	DO-BTA	Stainless Steel Temperature Probe	TMP-BTA
Dual-Range Force Sensor	DFS-BTA	Extra-Long Temperature Probe	TPL-BTA
Electrode Amplifier	EA-BTA	Surface Temperature Sensor	STS-BTA
Flow Rate Sensor	FLO-BTA	Thermocouple	TCA-BTA
Force Plate	FP-BTA	Turbidity Sensor	TRB-BTA
Gas Pressure Sensor	GPS-BTA	UVA Sensor	UVA-BTA
Hand Dynamometer	HD-BTA	UVB Sensor	UVB-BTA

Building a robot that searches for magnets from STEM 2 with Vernier and LEGO MINDSTORMS NXT *lab book*

NXT Sensor Adapter

ORDER CODE **BTA-NXT**

- Connect any one of 35 Vernier sensors to the NXT Intelligent Brick (see above).
- Create sensor-based control systems.
- Use with LEGO MINDSTORMS NXT, NI LabVIEW, or ROBOLAB.

Did you know? LEGO has a new robotics system called EV3. Our NXT Sensor Adapter and Vernier sensors can be used with EV3. See **www.vernier.com/lego-ev3**

Turning on a "drinking fountain" based on position and velocity measurements from a motion detector.

EASY STEPS FOR CONTROLLING DCU OUTPUT IN LOGGER *PRO*

1. Select the DCU line or lines you want to activate.
2. Build a logic statement to activate the line when this statement is true.
3. Choose AND, UNTIL, or OR to create a compound statement.

Creating a logic statement in Logger Pro *to turn on DCU line 1 when the position measurement is less than 0.5 meters AND the velocity measurement is greater than -0.1 meters/second*

IMPROVED Digital Control Unit

Digital Control Unit (DCU), ORDER CODE **DCU-BTD**

Using a DCU with your standard Vernier sensors provides a perfect way to implement Next Generation Science Standards (NGSS) in the classroom. It provides a quick and easy way to control inexpensive DC devices (motors, buzzers, LEDs, etc) with your Logger *Pro* software. The engaging quality of DCU projects will appeal to students who may not necessarily be drawn to engineering or computer programming.

Connecting a DCU is easy. Connect it to a digital port of any Vernier interface, and you are ready to go.

The DCU's new connector provides two easy ways to connect your electrical device: connect the device to the DCU header pins or screw the electrical device's wires into the DCU's detachable screw terminal.

Once the electrical device is attached to the DCU, an external power supply, such as the LabQuest or LabPro power supply (not included, ORDER CODE IPS or LQ-PS), is required to power the device.

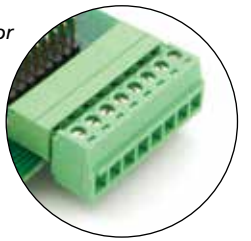
Sample DCU Sensor-Based Projects

- The temperature of a small enclosure is manipulated with the control of a fan
- A motion detector detects the presence of your hands and turns on a hand dryer
- An EKG Sensor is used to illuminate an LED when you blink your eye
- A pump and valve are controlled to build an automated blood pressure system
- A photogate and force sensor are used to build an automatic drink dispenser

See more project ideas at **www.vernier.com/engineering/stem**

The DCU can also be controlled using National Instruments LabVIEW for Education software. In addition, the DCU can be connected to an Arduino or NI myDAQ (see page 65).

NEW
Connector



Watch a Tech Tip Video describing how to use the DCU in Logger Pro *at* ***www.vernier.com/v136***

About Project Lead The Way

Project Lead The Way (PLTW) is the nation's leading provider of in-school STEM curriculum. Through world-class, activity-, project-, and problem-based curriculum designed for elementary, middle, and high school students, PLTW helps students develop the skills needed to succeed in our global economy.

PLTW delivers programs to over 5,200 schools in all 50 states and the District of Columbia. In addition, PLTW trained more than 3,500 teachers in 2013 using its high-quality professional development model.

Project Lead The Way and Vernier

Over the years, Vernier has developed a strong partnership with Project Lead The Way. We value their mission to prepare students for the global economy.

By providing a comprehensive curriculum package based on national standards, focusing on teacher training, and integrating Vernier technology, the PLTW biomedical and engineering programs are extremely valuable for schools integrating hands-on, project-based STEM.

Measuring EMG and muscle fatigue in the PLTW Biomedical Sciences Program

PLTW PROGRAMS

Biomedical Sciences (BMS)

PLTW's Biomedical Sciences program allows students to play the roles of biomedical professionals as they investigate and study the concepts of human medicine, physiology, genetics, microbiology, and public health. Through hands-on projects, students learn content in the context of real-world cases. They examine the structures and interactions of human body systems and explore the prevention, diagnosis, and treatment of disease, all while working collaboratively to understand and design solutions to the most pressing health challenges of today and the future.

Pathway To Engineering (PTE)

PLTW's Pathway To Engineering program allows students to engage in critical thinking and open-ended problem solving, learn and apply the engineering design process, and use the same industry-leading technology and software as the world's top companies. Students investigate topics such as aerodynamics and astronautics, biological engineering and sustainability, and digital electronics and circuit design, giving them an opportunity to learn about various engineering disciplines before beginning post-secondary education or careers.

Gateway To Technology (GTT)

Through topics like robotics, flight and space, and DNA and crime scene analysis, PLTW's GTT program provides a strong foundation for further STEM learning in high school and beyond. It challenges students to solve real-world problems, like cleaning oil spills and designing sustainable housing solutions, and provides them the opportunity to use the same advanced software and tools as the world's leading companies. The GTT program helps students see the application of math, science, technology, and engineering to their everyday lives.

National Instruments LabVIEW™ for Education Software

Graphical Programming Language for High School STEM Education

The National Instruments LabVIEW for Education software helps teachers bring STEM concepts to life through hands-on learning. This is industry-standard LabVIEW (used throughout the engineering disciplines) refined for classroom use, with modules for educational hardware, including these Vernier products:

- LabQuest/LabQuest 2
- LabQuest Mini
- SensorDAQ
- NXT Sensor Adapter
- Go! devices (Go!Link, Go!Temp, Go!Motion)

Full integration means that everything required for these Vernier products is included. Install NI LabVIEW for Education, connect the Vernier hardware, and begin running examples to

- Log and analyze data
- Introduce engineering measurement and automation concepts
- Build sensor-controlled NXT robots
- Perform feedback and control
- Introduce biomedical concepts with physiology sensors

Single-User NI LabVIEW for Education, ORDER CODE **LV4E-1**
10-User NI LabVIEW for Education, ORDER CODE **LV4E-10**
LabVIEW for Education Site License, ORDER CODE **LV4E-SITE**
Windows and Mac versions are included. For more information, go to **www.vernier.com/labview**

License available to U.S. high schools only. NI LabVIEW for use outside the U.S., in colleges and universities, or for individual use, should be purchased from National Instruments at **ni.com/academic**

NEW Vernier myDAQ Adapter

ORDER CODE **BT-MDAQ**

The Vernier myDAQ Adapter can be used to perform data acquisition with over 60 Vernier sensors and the NI myDAQ interface. In addition to connecting Vernier sensors, the adapter provides access to two myDAQ analog output terminals and three digital terminals (including the frequency and pulse width modulation [PWM] outputs).

Did you know? Vernier analog and digital sensors can be used with Arduino. A detailed guide for connecting, programming, and calibrating Vernier sensors with Arduino can be found at **www.vernier.com/arduino**

SensorDAQ—Designed by NI & Vernier for Engineering Education

Perfect for teaching NI LabVIEW or for building sensor-controlled student projects using NI LabVIEW software

SensorDAQ, a joint project of National Instruments and Vernier, is a USB data-acquisition interface that offers convenience and power to engineering students.

- Compatible with 68 Vernier analog and digital sensors. Go to **www.vernier.com/sdaq**
- Use with NI LabVIEW software version 2009 or newer (not included)
- Windows only

Not compatible with Logger Pro *or Logger Lite software*

ORDER CODE **SDAQ**

Includes: SensorDAQ, Voltage Probe, USB cable, user manual, and sample programs. SensorDAQ carries a one-year warranty.

Screw Terminal
Build circuits, control motors, create custom sensors, and more
- 2 analog input
- 4 digital I/O
- 1 analog output
- 1 counter/pulse generator

1 Digital Sensor Channel
Connect any Vernier digital sensor

3 Analog Sensor Channels
Connect any Vernier analog sensor

Fast Sampling Rate
Up to 48,000 samples per second

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Learn how to program with NI LabVIEW with our *Hands-On Introduction to NI LabVIEW* book. Then, take your LabVIEW programming to the next level with the *Engineering Projects with NI LabVIEW and Vernier* book.

2 CHOOSE YOUR INTERFACE

We recommend the SensorDAQ as our Engineering interface to use with NI LabVIEW software.

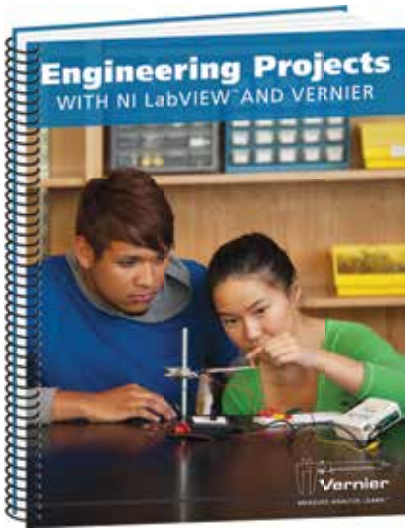
LabQuest and LabQuest Mini can also be programmed with NI LabVIEW and are supported by the Engineering lab books.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

4 ADD A COPY OF NI LABVIEW™ SOFTWARE

We recommend NI LabVIEW for Education, which introduces students to a powerful engineering software. See page 65 for details.



ENGINEERING PROJECTS BOOK

ORDER CODE **EPV** GREAT VALUE!

This lab book contains engaging hands-on projects for SensorDAQ, LabQuest, LabQuest 2 or LabQuest Mini. It introduces engineering concepts and programming with NI LabVIEW development software. An introductory knowledge of NI LabVIEW programming is assumed (see our *Hands-On Introduction to NI LabVIEW* book). When you buy the lab book, you will receive

- Essential teacher information
- 12 projects with challenge exercises
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all experiments and teacher files on CD.
- NI LabVIEW sample programs on CD for each project and challenge

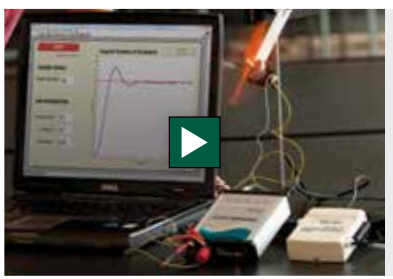
The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/epv**

Engineering Projects with NI LabVIEW and Vernier contains the following projects:

- ☐ ■ Build a Temperature Sensor
- ☐ ■ Digital Control Systems
- ☐ ■ 3-Color LED
- ☐ ■ Hot Wire Anemometer
- ■ DC Motor Control
- ☐ ■ Light Intensity
- ■ Servo Motor
- ☐ ■ EKG
- ■ Blood Pressure
- ☐ ■ Strain Gage Measurement
- ■ Propeller Control
- ■ Ping-Pong Ball Levitation

☐ STARTER PACKAGES ■ DELUXE PACKAGES



A GREAT WAY TO TEACH STEM

This book introduces many important science and engineering concepts, including analog and digital input, sensors and how they are calibrated, feedback and control, analog and digital output, servo and stepper motors, PID control, pulse-width modulation, voltage dividers, and Wheatstone bridges.

Videos of many of these projects are available at **www.vernier.com/epv-videos**

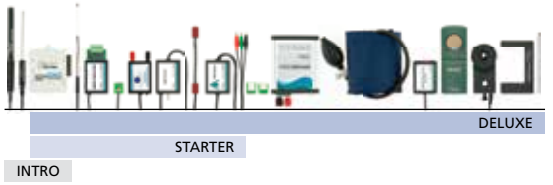
Engineering NI LabVIEW Packages

Purchase one package per lab group (2–4 students).

SensorDAQ

*Packages are also available with LabQuest 2 and LabQuest Mini. See **www.vernier.com/engpkg***

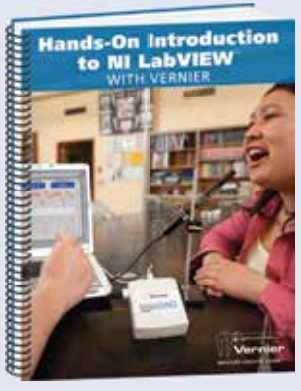
SENSORDAQ AND SENSORS	CODE	Intro to NI LabVIEW Package **SD-EE**	Engineering Projects with NI LabVIEW Starter **SD-EP-ST**	Engineering Projects with NI LabVIEW Deluxe **SD-EP-DX**
Microphone	MCA-BTA	✔	—	—
Stainless Steel Temperature Probe	TMP-BTA	✔	—	—
SensorDAQ	**SDAQ**	✔	✔	✔
Surface Temperature Sensor	STS-BTA		✔	✔
Digital Control Unit	DCU-BTD		✔	✔
Breadboard Cable	BB-BTA		✔	✔
Instrumentation Amplifier	INA-BTA		✔	✔
Light Sensor	LS-BTA		✔	✔
EKG Sensor	EKG-BTA		✔	✔
Analog Proto Board Connector	BTA-ELV			✔
Digital Proto Board Connector	BTD-ELV			✔
Power Amplifier	PAMP			✔
Blood Pressure Sensor	BPS-BTA			✔
Motion Detector	MD-BTD			✔
Rotary Motion Sensor	RMV-BTD			✔
Photogate	VPG-BTD			✔
SENSORDAQ	ENGINEERING NI LABVIEW PACKAGE			



YOU MAY ALSO NEED:

LabVIEW for Education Software (one per seat)
ORDER CODE **LV4E-1** (single user), or
ORDER CODE **LV4E-10** (10 users), or
ORDER CODE **LV4E-SITE** (site license)

One or both Engineering lab books:
Hands-On Introduction to NI LabVIEW™ with Vernier
ORDER CODE **LWV**
Engineering Projects with NI LabVIEW™ and Vernier
ORDER CODE **EPV**



HANDS-ON INTRODUCTION TO NI LABVIEW™ WITH VERNIER LAB BOOK

ORDER CODE **LWV**

This book introduces NI LabVIEW programming through a series of hands-on exercises using Vernier sensors and SensorDAQ, LabQuest, LabQuest 2, or LabQuest Mini. All of these chapters can be completed with the SD-EE package. Contents include

Getting Started
- Exercise 1 – Open and Run a LabVIEW Example VI

NI LabVIEW Environment
- Exercise 2 – Read Microphone Data

NI LabVIEW Programming
- Exercise 3 – Read and Analyze Microphone Data

Working with Loops
- Exercise 4 – Continuous Read and Analyze Microphone Data

Presenting Results
- Exercise 5 – Read Temperature Data

Decision Making
- Exercise 6 – Above Threshold Warning of Temperature Data

SubVIs
- Exercise 7 – Create a Temperature Conversion SubVI

SensorDAQ Automation*
- Exercise 8 – Control Analog Out, Digital Out, and Pulse Out

Projects
- Output a tone from your computer proportional to a sensor reading.
- Display what key is pressed on a cell phone by analyzing the frequency of the tone.

* Can only be done with SensorDAQ

1 IT ALL STARTS WITH CURRICULUM

Looking to introduce inquiry into your curriculum? Start with a Vernier lab book. Aligned to state and national science standards, our lab book contains environmental science inquiry investigations.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

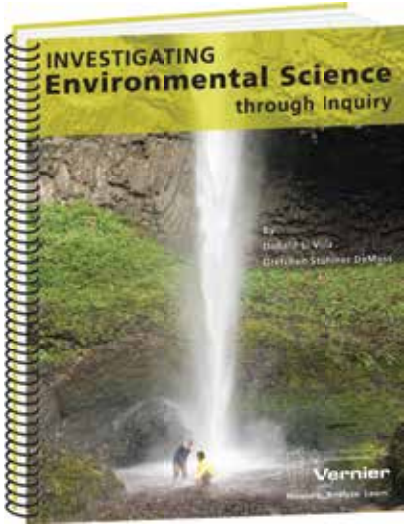
Our Deluxe Package contains all the sensors needed to perform every experiment in our environmental science lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



ENVIRONMENTAL SCIENCE LAB BOOK

ORDER CODE **ESI** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- 34 inquiry-based, environmental science investigations
- Essential teacher information for successful inquiry investigations
- Suggested researchable questions, sample data, and graphs
- A generous site license. Buy one book and duplicate labs for your class
- Microsoft® Word® files on CD for the experiments so you can easily edit labs to meet your personal teaching style

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/esi**

Investigating Environmental Science through Inquiry lab book contains the following inquiry experiments:

USING A TEMPERATURE PROBE
- Seasons and Angle of Insolation
- A Local Weather Study
- Water Quality
- Long Term Water Monitoring
- Soil Temperature
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- Global Warming
- Insulation Study
- Fossil Fuel Energy
- Energy Conversion
- An Investigation of Passive Solar Heating
- A Pollution Study

USING A TURBIDITY SENSOR
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- Population Dynamics
- A Pollution Study

USING A pH SENSOR
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- Soil pH
- Soil and Acid Precipitation
- Water Cycle Column Investigations
- Decomposition Column Investigations
- The Effect of Acid Deposition on Aquatic Ecosystems
- A Pollution Study
- Ecocolumn Investigations

USING A CONDUCTIVITY SENSOR
- Water Quality
- Long Term Water Monitoring
- Water Treatment
- Investigating Salinity
- Soil Salinity
- Water Cycle Column Investigations
- Ecocolumn Investigations
- The Effect of Acid Deposition on Aquatic Ecosystems

USING A SOIL MOISTURE SENSOR
- Soil Moisture
- Managing Garden Soil Moisture
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Ecocolumn Investigations
- A Pollution Study

USING A DISSOLVED OXYGEN PROBE
- Investigating Dissolved Oxygen
- Water Quality
- Long Term Water Monitoring
- Biochemical Oxygen Demand
- Primary Productivity
- A Pollution Study

USING A UV SENSOR
- A Local Weather Study
- UV Investigations
- ▶ Comparing Sunscreens

USING A VOLTAGE & CURRENT PROBE
- Wind Power
- Photovoltaic Cells

USING A RELATIVE HUMIDITY SENSOR
- A Local Weather Study
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- A Pollution Study

USING A LIGHT SENSOR
- Biodiversity in Ecosystems
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Ecocolumn Investigations
- Measuring Particulates
- Energy Conversions

USING A CO_2 GAS SENSOR
- ▶ Cell Respiration
- Water Cycle Column Investigations
- Decomposition Column Investigations
- Investigating Indoor Carbon Dioxide Concentrations
- A Pollution Study
- Ecocolumn Investigations

STARTER PACKAGES DELUXE PACKAGES ▶ VIDEO ONLINE

Environmental Science LabQuest 2 Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-EV-OST	Deluxe Package LQ2-EV-ODX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
Conductivity Probe	CON-BTA	✔	✔
Vernier Optical DO Probe*	ODO-BTA	✔	✔
Soil Moisture Sensor	SMS-BTA	✔	✔
Turbidity Sensor	TRB-BTA	✔	✔
Relative Humidity Sensor	RH-BTA		✔
UVB Sensor	UVB-BTA		✔
CO_2 Gas Sensor	CO2-BTA		✔
Voltage Probe	VP-BTA		✔
Current Probe	DCP-BTA		✔
Light Sensor	LS-BTA		✔

YOU MAY ALSO NEED:

***Investigating Environmental Science through Inquiry* lab book,** ORDER CODE **ESI**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 ENVIRONMENTAL SCIENCE PACKAGES

*Packages containing the Dissolved Oxygen Probe are available online.

AP* AND IB† ENVIRONMENTAL SCIENCE

AP Environmental Studies program and the IB Environmental Systems and Societies programs both recommend a strong laboratory and field investigation component. The *Investigating Environmental Science through Inquiry* lab book includes experiments correlated to both AP and IB standards. Environmental topics include

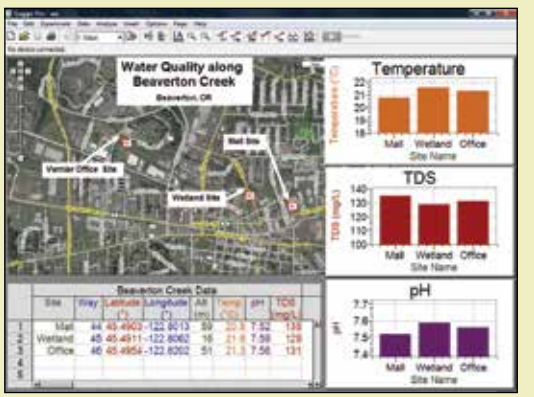
- Earth Systems and Resources—Air and Water
- Earth Systems and Resources—Soil
- The Living World
- Pollution
- Energy Resources and Consumption

MORE ONLINE – For correlations of Vernier labs to AP/IB objectives, visit **www.vernier.com/environmental/**

* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product. † The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

BUILT-IN GPS

The built-in GPS in LabQuest 2 makes it easy to add location information to your field data. When finished, simply transfer the data to Logger *Pro* and then export to Google Maps™ or GIS software.



Did you know? All IB Group 4 experimental science courses now require students to use sensors for data logging in an experiment and software for graph plotting.

NEW KidWind by Vernier

Kidwind Project—Teaching the World About Wind

KidWind and Vernier have teamed up to bring you the latest in renewable energy education. For over a decade, KidWind has been a leader in renewable energy education and the delivery of green STEM education. Their standards-based educational tools explore the science and technology of wind, solar, and other forms of renewable energy and their impact on the environment.

Through KidWind's extensive training network, teacher trainings, and the KidWind Challenge, a student wind turbine design competition, KidWind brings hands-on applications of their materials to teachers and students worldwide.

Collecting wind power data from a KidWind wind turbine

KIDWIND AND VERNIER

Vernier technology is used at KidWind trainings and KidWind Challenges. It allows participants to explore electrical concepts and quantify energy and power of small wind turbines and solar power.

For more information on KidWind, visit **learn.kidwind.org**

DATA COLLECTION WITH KIDWIND AND VERNIER

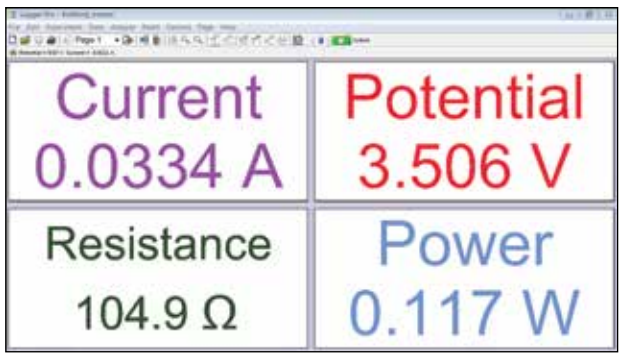
KidWind and Vernier offer a perfect solution for data collection for renewable energy and the Science and Engineering Practices for NGSS. You will need the following to collect data:

- LabQuest Mini (LQ-MINI) or LabQuest 2 (LABQ2)
- Logger *Pro* software (if using LabQuest Mini) (LP)
- 30 V Voltage Probe (30V-BTA)
- High Current Sensor (HCS-BTA)
- Resistor Board (VES-RB)
- KidWind Advanced or Basic Wind Experiment Kit (see page 71)

CURRICULUM

KidWind and Vernier have jointly developed experiments for you to use in your classroom. Explore wind turbines and variables affecting wind turbine power and energy output with free experiments available for download from **www.vernier.com/kidwind**

A box fan provides a wind source for a KidWind turbine.



Data from a KidWind turbine using Logger Pro

KidWind Experiment Kits

a. NEW Advanced Wind Experiment Kit

ORDER CODE **KW-AWX**

Discover advanced concepts of wind turbine technology! Students can explore gearboxes and airfoils. They can also construct blades to generate electricity, lift weights, and pump water. This kit is perfect for grades 7–12 and is all inclusive. You will need your own wind source, basic tools, and imagination!

Advanced Wind Experiment Kit Classroom Pack

ORDER CODE **KW-AWXC**

The classroom pack option includes three turbines, extra hubs, and blade consumables (for approximately 24 students).

---

b. NEW Basic Wind Experiment Kit

ORDER CODE **KW-BWX**

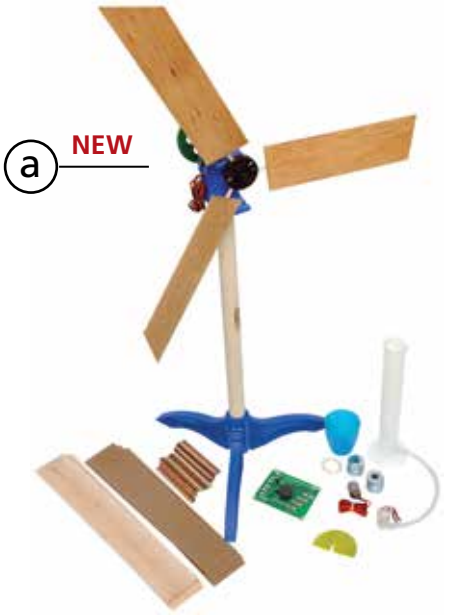
Explore wind energy affordably and easily. This kit allows students to test a variety of blade designs, generate electricity, and lift weights. The Basic Wind Experiment Kit has all the materials you need to get started understanding wind power. You provide the wind, basic tools, and your imagination. Great for grades 4–12 and groups, as well as individual science fair projects.

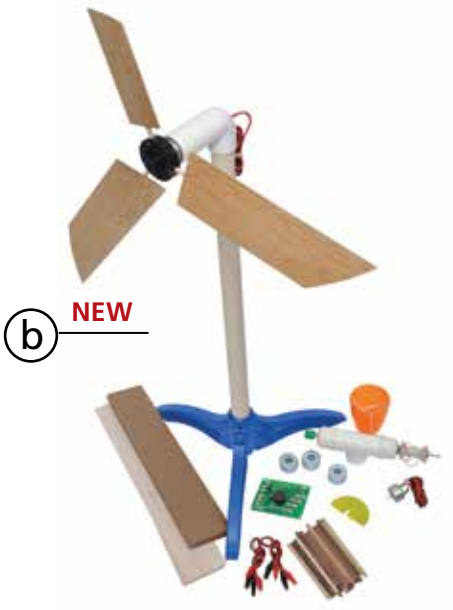
Basic Wind Experiment Kit Classroom Pack

ORDER CODE **KW-BWXC**

The classroom pack option includes three turbines and extra hubs and blade consumables (for approximately 24 students).

For information on kit contents and additional KidWind accessories visit **www.vernier.com/kidwind**





NEW a

a. NEW MINI Wind Turbine

ORDER CODE **KW-MWT**

Demonstrate the power of the wind with an affordable and rugged wind turbine. This is an easy-to-build turbine that will light an LED bulb and play a tune. The highly efficient blades produce plenty of power in a slight breeze.

b. NEW MINI Wind Turbine with Blade Design, ORDER CODE KW-MWTBD

The MINI with Blade Design allows students to perform basic blade experiments on a desk using a small house fan.

TURBINE PARTS

NEW b

c. NEW Basic Turbine Building Parts

ORDER CODE **KW-BTPART**

The Basic Turbine Building Parts kit includes the KidWind Hub, a wind turbine generator, and 25 dowels, all in one package.

These are the bare-bones components to build your own experimental wind turbine. This package is great for students who do not want a ready-made wind turbine tower and base, and for educators who want an affordable way for each of their students (or student groups) to do hands-on experiments with wind power.

NEW Basic Turbine Building Parts 10 Pack, ORDER CODE KW-BTPART10

Includes 10 Basic Turbine Building Parts Kits and a free Blade Pitch Protractor.

NEW c

For information on complete kit contents and additional KidWind parts and accessories visit **www.vernier.com/kidwind**

Collecting data with the MINI Wind Turbine and LabQuest 2

NEW Wind Turbine Hub

ORDER CODE **KW-WTH**

This 12-hole crimping hub allows you to turn any DC generator into a wind turbine. The hub will press fit onto the shaft of many small DC generators; just attach your own blades and begin experimenting with wind power. The hub is designed to allow you to change blade angles and/or interchange blade sets quickly and easily. The stainless-steel insert can take a beating in your classroom year after year without failing!

NEW Wind Turbine Hub 10 Pack

ORDER CODE **KW-WTH10**

Includes 10 Wind Turbine Hubs.

KidWind Solar Panels

Collecting solar energy data

NEW 2V/400mA Solar Panel

ORDER CODE **KW-SP2V**

This high-quality solar panel is great for demonstrations and experiments. External screw terminals and attached clip cords make the panels easy to use.

NEW 12V/500mA Solar Panel

ORDER CODE **KW-SP12V**

The powerful 12V/500mA (6 watt) Solar Panel is great for classroom experiments and basic applications that require more power. The aluminum frame glass-laminated solar module allows for more robust solar experiments. Suitable for long term outdoor use, this panel can function as a power source for many devices. You can quickly connect electrical devices and circuits with large clamps on 20-inch wire. The panel is PET laminated, so it will still work under rainy conditions.

Please note: The 12 V panel is not recommended for use with small load devices, such as small motors, water pumps, sound and light boards, or LEDs. When applying power to an electrical device, you need to verify the max power input because you may damage the device.

TURBINE PARTS (continued)

d. NEW Blade Design Consumables Classroom Pack, ORDER CODE KW-BDC

Bulk balsa, chipboard sheets, and dowels for blade making in the classroom. Pack includes 75 balsa sheets, 150 chipboard sheets, and 250 dowels.

e. NEW Dowels – 25 Pack

ORDER CODE **KW-D25**

These dowels are used for designing and testing wind turbine blades, and they fit into the KidWind Wind Turbine Hub. Students can design blades using materials like balsa wood or chipboard sheets and attach their blades to the 1/4-inch dowels using glue or tape.

NEW Dowels – 100 Pack

ORDER CODE **KW-D100**

f. NEW Wind Turbine Generator

ORDER CODE **KW-GEN**

This is the primary generator for wind turbine experiments because it runs smoothly and provides high power output at a relatively low RPM. This is the competition generator used in KidWind Challenge events.

This generator has 4-foot leads that are attached with shrink-wrapped, reinforced soldering. Typical output in non-geared wind devices is 0.5–2.5 V at 0.1–0.3 A.

g. NEW Blade Pitch Protractor

ORDER CODE **KW-BPP**

This tool is incredibly helpful for measuring the blade pitch angle on your KidWind turbine. This tool has a cut-out notch to fit around the blade dowel, and it has ridges on the back that align with the KidWind Hub, making it perfect for reading, measuring, and comparing blade pitch angles.

d NEW

e NEW

f NEW

g NEW

a

b

c

NEW

d

e

a. LabQuest Battery Boost 2

ORDER CODE **LQ-BOOST2**

The LabQuest Battery Boost 2 is a rechargeable external battery for your LabQuest or LabQuest 2 interface. With the added power of an external battery, data can be collected for extended periods in the field, where AC power is not available.

b. Anemometer, ORDER CODE ANM-BTA

The Vernier Anemometer is a handheld, impeller-type anemometer that measures wind speed in the range of 0.5 to 30 m/s (1 to 67 mph). A standard camera mount on the back and an accessory rod allows you to position it in wind tunnels or in front of fans for wind turbine experiments.

c. Soil Moisture Sensor, ORDER CODE SMS-BTA

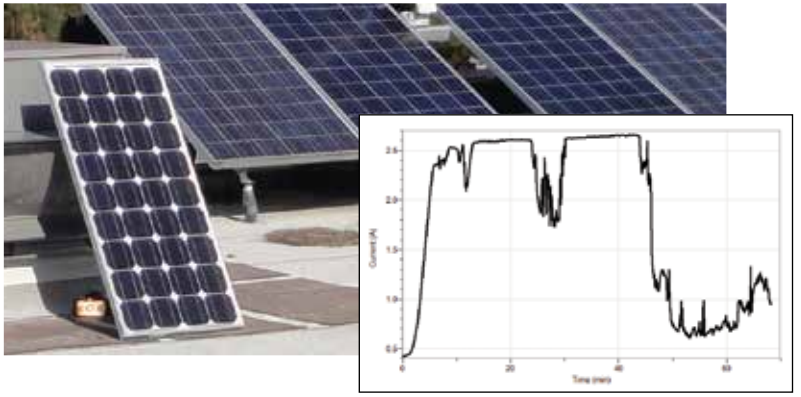
Simply insert this rugged sensor in soil and the volumetric water content is reported in percent. Use it to conduct experiments in ecology, environmental science, agricultural science, horticulture, biology, and more.

d. NEW PAR Sensor, ORDER CODE PAR-BTA

The PAR (Photosynthetically Active Radiation) Sensor measures photosynthetic light levels in both air and water. It features a waterproof sensor head and can be used to measure Photosynthetic Photon Flux Density (PPFD) from sunlight and electric light sources. It is sensitive to visible light in the spectral range that is used by plants in photosynthesis (400–700 nm).

e. Pyranometer, ORDER CODE PYR-BTA

The Pyranometer measures the power of electromagnetic radiation. It is sensitive to near infrared, visible, and UV radiation, where 90% of solar energy is concentrated. It reads in watts per square meter, so it is great for experiments with solar cells and calculating their efficiency.



Current from a solar panel

HIGH CURRENT SENSOR

Do you do experiments with solar panels or other high-current devices? Our High Current Sensor can handle the higher currents from hand-crank generators, large batteries, and solar panels.

The Vernier High Current Sensor has a range of ±10 A. Current is measured with a Hall effect sensor, which uses the magnetic field created by the current. This means that no sense resistor is required, reducing the effect of the sensor on your circuit. A magnetic shield keeps measurements undisturbed by external fields. There is a user-replaceable fuse inside to protect the sensor.

The graph shows the current from a solar panel, which requires the wider range of the High Current Sensor.

For currents below 600 mA, the original Current Sensor (DCP-BTA) is still available and is the better choice for low-current experiments.

30-VOLT VOLTAGE PROBE

We also have a 30-Volt Voltage Probe that's great for using with large solar panels such as the KidWind 12V/500mA Solar Panel on page 73.

ORDER CODE **HCS-BTA**

ORDER CODE **30V-BTA**

Experiment 10 from* Middle School Science with Vernier, *"What Causes the Seasons?"

PRIMARY

Getting Started

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• Force Plate 78
• Magnetic Field Sensor 78

1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest, computers, and TI graphing calculators.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

Vernier Go!Link – The Go!Link USB interface connects any one of 54 Vernier sensors to your computer. More details on page 20.

3 CHOOSE YOUR SENSORS

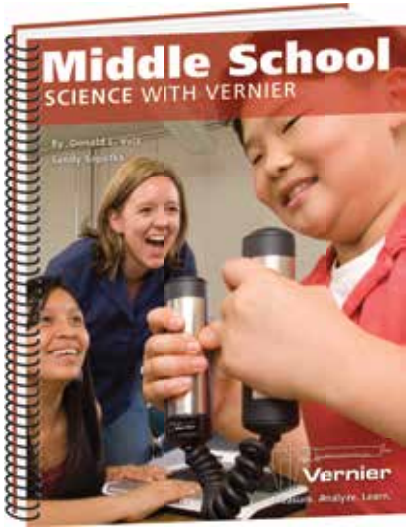
Choose from Vernier's recommended packages or build your own from our list of sensors.

Our Deluxe Package contains all the sensors needed to perform every experiment in our middle school lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – For more advanced users, this award-winning software is the best value around! Includes a site license for all computers in your school, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.



MIDDLE SCHOOL SCIENCE LAB BOOK

ORDER CODE **MSV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information
- 38 ready-to-use student versions of computer experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Microsoft® Word® files for all versions of the experiments on CD so you can easily edit labs to meet your personal teaching style
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/msv**

Middle School Science with Vernier lab book contains the following experiments:

☐☐ **USING TEMPERATURE PROBES**
- A Hot Hand
- Heating of Land and Water
- The Greenhouse Effect
- Relative Humidity
- Absorption of Radiant Energy
- Schoolyard Study
- A Good Sock
- What Causes the Seasons?
- Solar Homes
- Boiling Temperature of Water
- Freezing Temperature of Water
- How Low Can You Go?
- A Good Cold Pack
- A Water Field Study
- Cooling Rates: Shaq *vs.* Susie

☐☐ **USING A pH SENSOR**
- Soil Study
- A Water Field Study

☐☐ **USING A VOLTAGE PROBE**
- Lemon "Juice"

☐☐ **USING A MOTION DETECTOR**
- Ocean Floor Mapping
- Graphing Your Motion
- Velocity
- A Speedy Slide
- The Indy 100
- Crash Dummies
- Falling Objects

☐☐ **USING A LIGHT SENSOR**
- Reflectivity of Light
- Schoolyard Study

☐☐ **USING A FORCE SENSOR**
- Friction
- First-Class Levers
- Pulleys
- Buoyancy

☐☐ **USING A CONDUCTIVITY PROBE**
- Water Hardness Study
- Diffusion: How Fast?
- A Water Field Study

☐☐ **USING A GAS PRESSURE SENSOR**
- Get a Grip!
- Fun with Pressure
- Yeast Beasts in Action

☐☐ **USING A HAND-GRIP HEART RATE MONITOR**
- Heart Rate and Body Position
- Heart Rate and Exercise

☐☐ **USING A MAGNETIC FIELD SENSOR**
- Mapping a Magnetic Field
- Electromagnets

☐ STARTER PACKAGES ☐ DELUXE PACKAGES

Look for training videos of some of these labs at **www.vernier.com/videos**

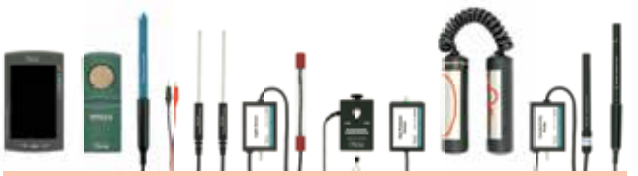
Middle School Science LabQuest 2 and Go!Link Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-MS-ST	Deluxe Package LQ2-MS-DX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Motion Detector	MD-BTD	✔	✔
pH Sensor	PH-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔ ✔	✔ ✔
Light Sensor	LS-BTA	✔	✔
Dual-Range Force Sensor	DFS-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
Conductivity Probe	CON-BTA		✔
Magnetic Field Sensor	MG-BTA		✔



YOU MAY ALSO NEED:

Middle School Science with Vernier **lab book**
ORDER CODE **MSV**

Logger Lite software
Free download at **www.vernier.com/logger-lite**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 MIDDLE SCHOOL SCIENCE PACKAGE

Go!Link

USB Computer Interface

GO!LINK INTERFACE & SENSORS	CODE	Starter Package MSS-GO-STR	Deluxe Package MSS-GO-DX
Vernier Go!Link Interface	**GO-LINK**	✔	✔
Go!Motion	GO-MOT	✔	✔
pH Sensor	PH-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
(2) Go!Temp	GO-TEMP	✔ ✔	✔ ✔
Light Sensor	LS-BTA	✔	✔
Dual-Range Force Sensor	DFS-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔
Hand-Grip Heart Rate Monitor	HGH-BTA		✔
Conductivity Probe	CON-BTA		✔
Magnetic Field Sensor	MG-BTA		✔

YOU MAY ALSO NEED:

Middle School Science with Vernier **lab book**
ORDER CODE **MSV**

Logger Lite software—included **FREE.**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI MIDDLE SCHOOL SCIENCE PACKAGE

MORE ONLINE – For additional middle school package options, visit www.vernier.com/middle-school

Go!Temp
ORDER CODE **GO-TEMP**

Connect directly to the USB port on your computer to collect temperature data. For more details, see page 21.

Let's Go! Investigating Temperature Lab Book
ORDER CODE **ELB-TEMP**

A collection of 10 temperature experiments for computer or LabQuest. These labs are also included in the *Elementary Science with Vernier* book.

Magnetic Field Sensor
ORDER CODE **MG-BTA**

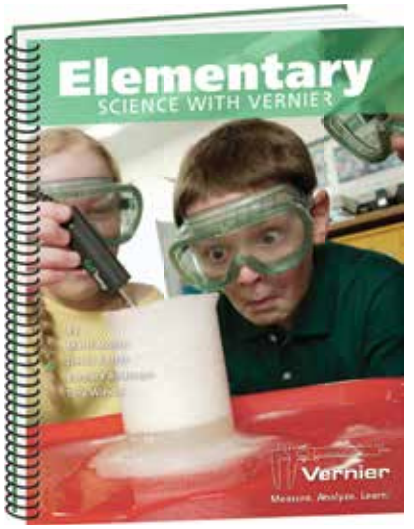
Study the magnetic field surrounding various types of magnets.

Force Plate
ORDER CODE **FP-BTA**

The Force Plate is a large force sensor—tough enough to jump on. Two handles are included for pushing or pulling. For more details, see page 132.

Go!Motion
ORDER CODE **GO-MOT**

Connect directly to the USB port on your computer to collect position, velocity, and acceleration data. For more details, see page 21.



ELEMENTARY SCIENCE LAB BOOK

ORDER CODE **EWV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 43 ready-to-use student versions of Logger Lite experiments and one project in print; LabQuest and computer versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Microsoft® Word® files on CD for the experiments so you can easily edit labs to meet your personal teaching style
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/ewv**

Elementary Science with Vernier lab book contains the following experiments:

USING A TEMPERATURE PROBE
- Learning to Use Go!Temp
- How do Mittens Keep You Warm?
- Baggie Mittens
- The Sole Purpose
- Cool Reaction!
- Cold as Ice
- Are We Cool or What?
- Why Do We Need Thermometers?
- Celsius and Fahrenheit, What's the Difference?
- Getting it JUST Right!
- Go!Temp Spends the Night
- Hold Everything! Comparing Insulators
- Keepin' it Cool! Design Your Own Thermos
- I'm Melting! Water Changes States
- Solid, Liquid, Gas: Water Can Do it All!

USING A TI LIGHT PROBE
- Learning to Use the Light Probe
- Distance From the Sun
- Sunshine on My Shoulders
- Summer and Winter
- Reflectivity of Light

USING A MOTION DETECTOR
- Learning to Use Go!Motion
- e-Motion
- Batty About Science
- Spring into Action
- Air Ball!
- Driving with Energy
- Weigh Station: All Trucks Stop!

USING A GAS PRESSURE SENSOR
- Learning to Use the Pressure Sensor
- Get a Grip!
- Under Pressure
- Bubbles in Your Bread

USING A MAGNETIC FIELD SENSOR
- Learning to Use the Magnetic Field Sensor
- Exploring the Poles
- Making Magnets
- Electromagnets

USING A DIFFERENTIAL VOLTAGE PROBE
- Learning to Use the Voltage Probe
- Are All Batteries the Same?
- Stacked Batteries
- All Worn Out!

USING A DUAL-RANGE FORCE SENSOR
- Learning to Use the Force Sensor
- Lift the Load
- What a Drag!
- Oh! My Aching Back! How Ramps Make Lifting Easier

STARTER PACKAGES DELUXE PACKAGES VIDEO ONLINE

Elementary Science LabQuest 2 and Go!Link Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

LABQUEST 2
CONNECTED SCIENCE SYSTEM

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-EL-ST	Deluxe Package LQ2-EL-DX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
TI Light Probe	TILT-BTA	✔	✔
Motion Detector	MD-BTD	✔	✔
Magnetic Field Sensor	MG-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔
Differential Voltage Probe	DVP-BTA		✔
Dual-Range Force Sensor	DFS-BTA		✔
LABQUEST 2	ELEMENTARY SCIENCE PACKAGE		

YOU MAY ALSO NEED:

***Elementary Science with Vernier* lab book**
ORDER CODE **EWV.** See previous page.

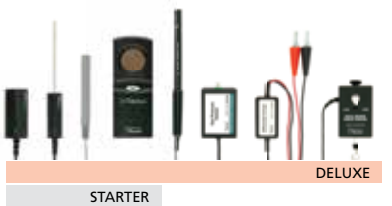
Logger Lite software
Free download at **www.vernier.com/logger-lite**

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

Go!Link

USB Computer Interface

GO!LINK INTERFACE & SENSORS	CODE	Starter Package ELEM-ST	Deluxe Package ELEM-DX
Vernier Go!Link Interface	**GO-LINK**	✔	✔
Go!Link Temperature Probe	GO-TEMP	✔	✔
TI Light Probe	TILT-BTA	✔	✔
Go!Motion - Motion Detector	GO-MOT	✔	✔
Magnetic Field Sensor	MG-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔
Differential Voltage Probe	DVP-BTA		✔
Dual-Range Force Sensor	DFS-BTA		✔
LABQUEST MINI	ELEMENTARY SCIENCE PACKAGE		



YOU MAY ALSO NEED:

***Elementary Science with Vernier* lab book**
ORDER CODE **EWV.** See previous page.

Logger Lite software—included **FREE**.

MORE ONLINE – For additional elementary package options, visit www.vernier.com/elementary

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2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

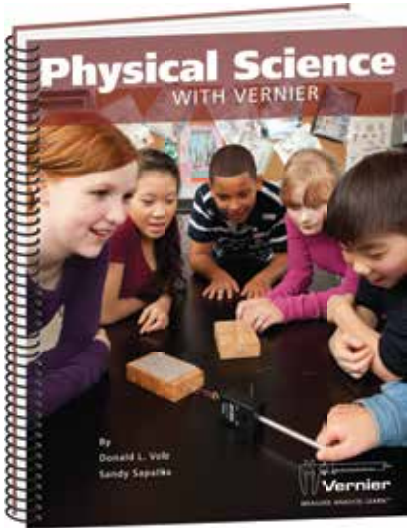
Our Deluxe Package contains all the sensors needed to perform every experiment in our physical science lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



PHYSICAL SCIENCE LAB BOOK

ORDER CODE **PSV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 40 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Microsoft® Word® files for all versions of the experiments on CD so you can easily edit labs to meet your personal teaching style
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/psv**

Physical Science with Vernier lab book contains the following experiments:

USING A TEMPERATURE PROBE
- Temperature Probe Response Time
- Boiling Temperature of Water
- Freezing and Melting of Water
- Evaporation of Alcohols
- Endothermic and Exothermic Reactions
- Neutralization Reactions
- Mixing Warm and Cold Water
- Heat of Fusion
- Energy Content of Fuels
- Energy Content of Foods
- Absorption of Radiant Energy
- An Insulated Cola Bottle
- A Good Sock
- Insolation Angle
- Solar Homes and Heat Sinks
- Gas Temperature & Pressure

USING A MOTION DETECTOR
- Velocity
- It's Race Day
- Momentum: A Crash Lesson
- Newton's Second Law
- Graphing Your Motion
- Falling Objects

USING A pH SENSOR
- Household Acids and Bases
- Acid Rain

USING A VOLTAGE PROBE
- Lemon "Juice"
- Lead Storage Batteries

USING A FORCE SENSOR
- Frictional Forces
- First-Class Levers
- Pulleys
- An Inclined Plane

USING A LIGHT SENSOR
- Reflectivity of Light
- Polaroid Filters
- How Bright is the Light?

MAGNETIC FIELD SENSOR
- Electromagnets: Winding Things Up
- Magnetic Field Explorations

USING A CONDUCTIVITY PROBE
- Conducting Solutions
- Conductivity of Salt Water
- Acid Strengths
- Neutralization Reactions

USING A GAS PRESSURE SENSOR
- Gas Pressure and Volume
- Gas Temperature and Pressure
- Fun with Pressure

STARTER PACKAGES | DELUXE PACKAGES | VIDEO ONLINE

Interested in Middle School Science? See pp. 76–77.

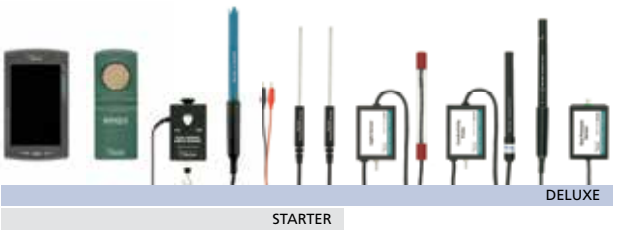
Physical Science LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-PS-ST	Deluxe Package LQ2-PS-DX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Motion Detector	MD-BTD	✔	✔
Dual-Range Force Sensor	DFS-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
Light Sensor	LS-BTA		✔
Conductivity Probe	CON-BTA		✔
Magnetic Field Sensor	MG-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔



YOU MAY ALSO NEED:

***Physical Science with Vernier* lab book,** ORDER CODE **PSV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

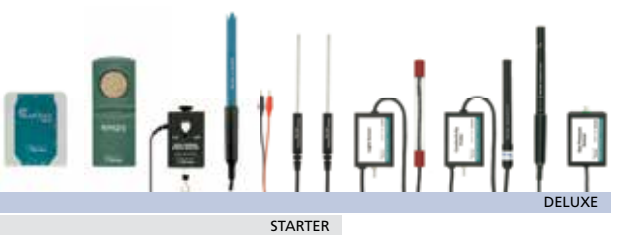
LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 PHYSICAL SCIENCE PACKAGE

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-PS-ST	Deluxe Package LM-PS-DX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
Motion Detector	MD-BTD	✔	✔
Dual-Range Force Sensor	DFS-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
(2) Stainless Steel Temperature Probes	TMP-BTA	✔✔	✔✔
Light Sensor	LS-BTA		✔
Conductivity Probe	CON-BTA		✔
Magnetic Field Sensor	MG-BTA		✔
Gas Pressure Sensor	GPS-BTA		✔

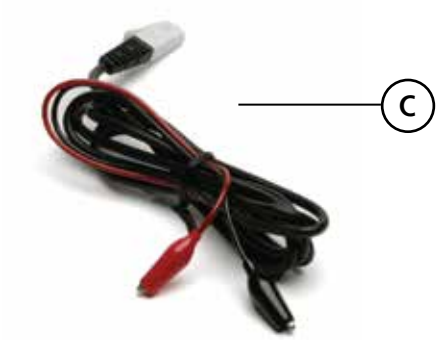


YOU MAY ALSO NEED:

***Physical Science with Vernier* lab book,** ORDER CODE **PSV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI PHYSICAL SCIENCE PACKAGE



a. Motion Detector, ORDER CODE MD-BTD

The Motion Detector can be used to study the motion of a cart on a ramp or a ball tossed into the air. You can also use it to teach your students how graphs work by having them try to move in front of the motion detector to match a distance *vs.* time or velocity *vs.* time graph.

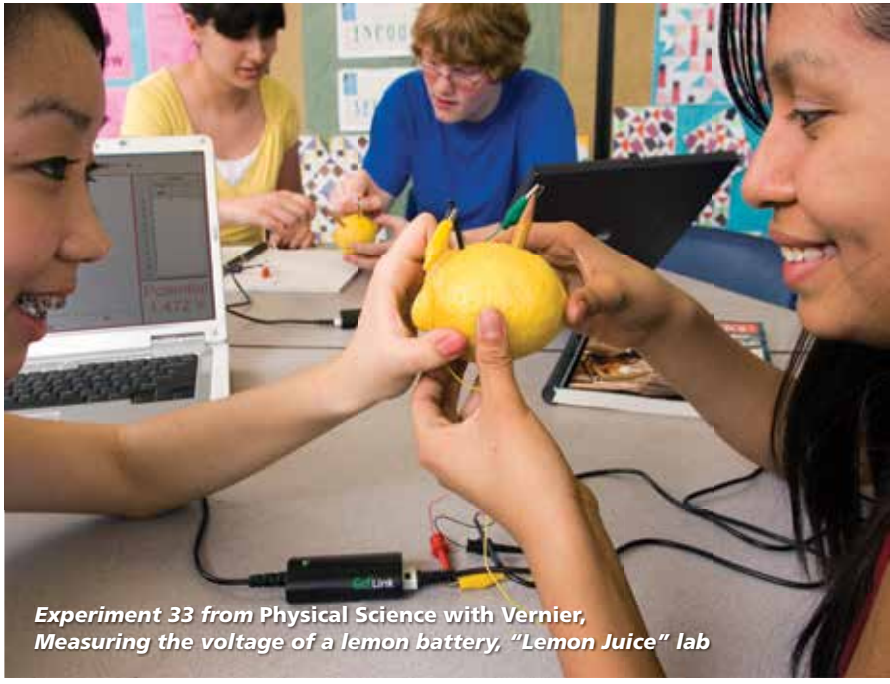
- Measure objects as close as 15 cm to the detector and as far away as 6 m.
- Pivoting head and rubber feet for ease of use

b. Light Sensor, ORDER CODE LS-BTA

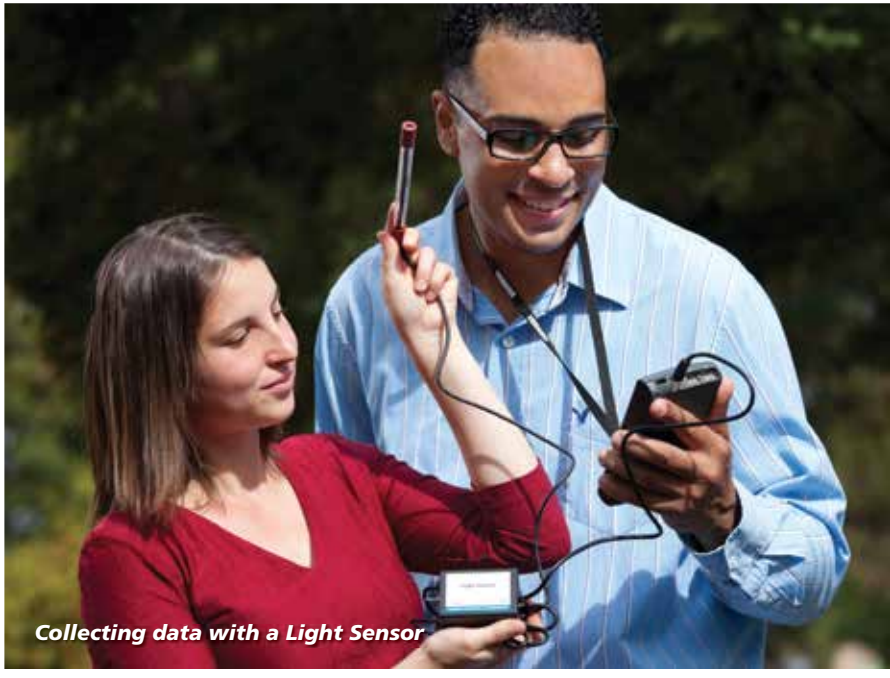
Our Light Sensor approximates the human eye in spectral response and can be used over three different illumination ranges, which you select with a switch. Use it for inverse square law experiments or for studying polarizers, reflectivity, or solar energy.

c. Voltage Probe, ORDER CODE VP-BTA

The Voltage Probe can be used to study voltages produced by simple voltaic cells (like the lemon battery, top right), for simple electric circuit labs, or to do battery life studies.



Experiment 33 from* Physical Science with Vernier, *Measuring the voltage of a lemon battery, "Lemon Juice" lab



Collecting data with a Light Sensor

The Vernier Motion Encoder System provides excellent data with no adjustments.

PHYSICS

Getting Started

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Curriculum

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SOFTWARE
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1 IT ALL STARTS WITH CURRICULUM

Want to save time? Start with a Vernier lab book. Aligned to state and national science standards, our lab books contain experiments for LabQuest, computers, and TI graphing calculators.

2 CHOOSE YOUR INTERFACE

Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

Vernier LabPro – LabPro works with computers or TI calculators. For information on data collection with TI graphing calculators, see pp. 117–123.

3 CHOOSE YOUR SENSORS

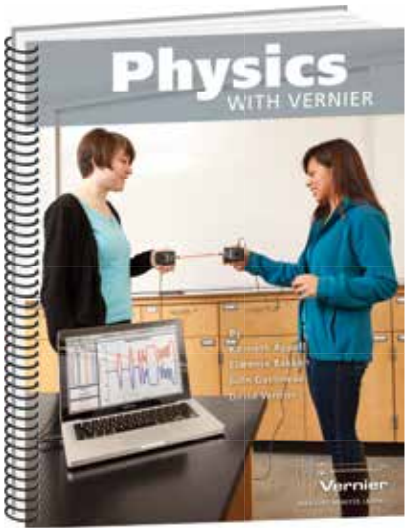
Choose from Vernier's recommended packages or build your own from our list of sensors.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



UPDATED PHYSICS LAB BOOK

ORDER CODE **PWV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information
- 35 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at www.vernier.com/pwv

Physics with Vernier lab book contains the following experiments:

USING A MOTION DETECTOR
- Graph Matching
- Cart on a Ramp
- Determining *g* on an Incline
- Ball Toss
- Air Resistance
- Simple Harmonic Motion
- Energy of a Tossed Ball
- Energy in Simple Harmonic Motion
- Momentum, Energy and Collisions
- Impulse and Momentum
- Back and Forth Motion
- Static and Kinetic Friction

USING A FORCE SENSOR
- Newton's Second Law
- Newton's Third Law
- Static and Kinetic Friction
- Impulse and Momentum

USING A MICROPHONE
- Sound Waves and Beats
- Tones, Vowels, and Telephones
- Mathematics of Music
- Speed of Sound

USING A DIFFERENTIAL VOLTAGE PROBE
- Capacitors

USING PHOTOGATES
- Picket Fence Free Fall
- Projectile Motion
- Atwood's Machine
- Pendulum Periods

USING A TEMPERATURE PROBE
- Newton's Law of Cooling

USING AN ACCELEROMETER
- Bungee Jump Accelerations
- Centripetal Accelerations on a Turntable
- Accelerations in the Real World
- Newton's Second Law

USING CURRENT & DIFFERENTIAL VOLTAGE PROBES
- Ohm's Law
- Series and Parallel Circuits
- Electrical Energy

USING A MAGNETIC FIELD SENSOR
- The Magnetic Field in a Coil
- The Magnetic Field in a Slinky
- The Magnetic Field of a Permanent Magnet

USING A LIGHT SENSOR
- Polarization of Light
- Light, Brightness, and Distance

STARTER PACKAGES DELUXE PACKAGES VIDEO ONLINE

Look for training videos of some of these labs at **www.vernier.com/videos**

Recommended Accessories

Vernier Dynamics System, pp. 94–95; **Picket Fence**, page 87; **Springs Set**, page 87; **Pulley Bracket**, page 95; **Optics Expansion Kit**, page 98; **Bumper and Launcher Kit**, page 95; **Polarizer/Analyzer Set for Optics Expansion Kit**, page 99; **Extech Digital DC Power Supply**, page 92; **Friction Pad**, page 95; **Independence of Motion Accessory**, page 101; **Time of Flight Pad**, page 101; **Circuit Board**, page 92; **Projectile Launcher**, page 101

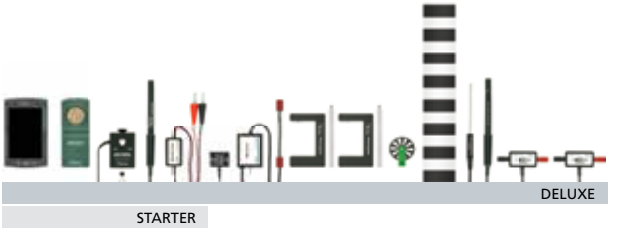
Physics LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-PHY-ST	Deluxe Package LQ2-PHY-DX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Motion Detector	MD-BTD	✔	✔
Dual-Range Force Sensor	DFS-BTA	✔	✔
Microphone	MCA-BTA	✔	✔
Differential Voltage Probe	DVP-BTA	✔	✔✔
Low-g Accelerometer	LGA-BTA		✔
Light Sensor	LS-BTA		✔
(2) Vernier Photogates	VPG-BTD		✔✔
Ultra Pulley Attachment	SPA		✔
Picket Fence	PF		✔
Stainless Steel Temperature Probe	TMP-BTA		✔
Magnetic Field Sensor	MG-BTA		✔
(2) Current Probes	DCP-BTA		✔✔



YOU MAY ALSO NEED:

***Physics with Vernier* lab book,** ORDER CODE **PWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

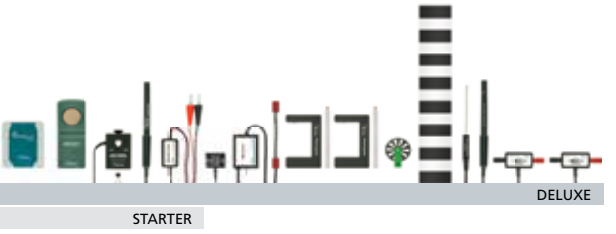
LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

LABQUEST 2 PHYSICS PACKAGES

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Starter Package LM-PHY-ST	Deluxe Package LM-PHY-DX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔	✔
Motion Detector	MD-BTD	✔	✔
Dual-Range Force Sensor	DFS-BTA	✔	✔
Microphone	MCA-BTA	✔	✔
Differential Voltage Probe	DVP-BTA	✔	✔✔
Low-g Accelerometer	LGA-BTA		✔
Light Sensor	LS-BTA		✔
(2) Vernier Photogates	VPG-BTD		✔✔
Ultra Pulley Attachment	SPA		✔
Picket Fence	PF		✔
Stainless Steel Temperature Probe	TMP-BTA		✔
Magnetic Field Sensor	MG-BTA		✔
(2) Current Probes	DCP-BTA		✔✔



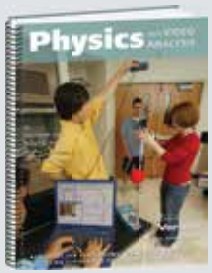
YOU MAY ALSO NEED:

***Physics with Vernier* lab book,** ORDER CODE **PWV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LABQUEST MINI PHYSICS PACKAGES

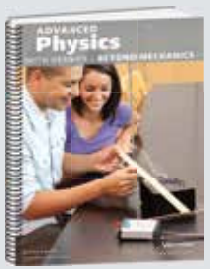
WE ALSO RECOMMEND:



Physics with Video Analysis **lab book**

ORDER CODE
PVA

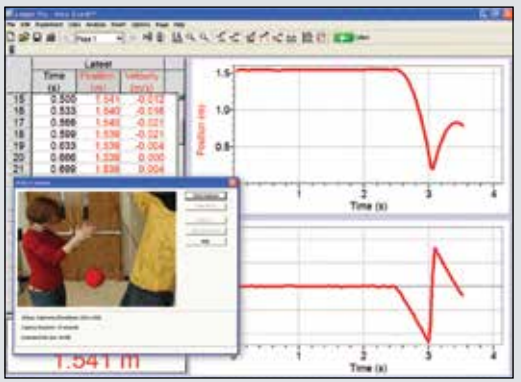
See page 102.



Advanced Physics with Vernier – Beyond Mechanics **lab book**

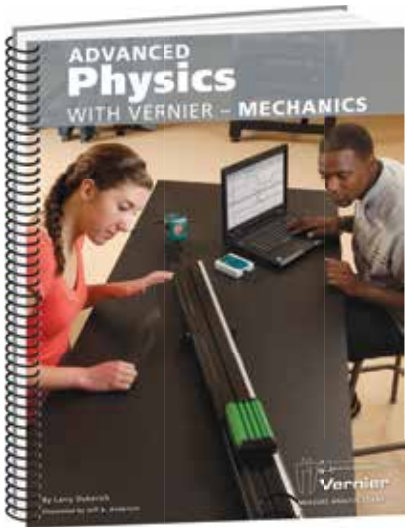
ORDER CODE
PHYS-ABM

See page 88.



Capture videos and sensor data using Logger Pro *3.*

MORE ONLINE – For FREE sample activities and videos go to **www.vernier.com/experiments**



ADVANCED PHYSICS – MECHANICS

ORDER CODE **PHYS-AM** GREAT VALUE!

Advanced Physics with Vernier – Mechanics is the first of a two-volume set of experiments for the more in-depth introductory physics course, such as college physics, AP Physics, or IB Physics.

- Experiments are designed for an interactive teaching style, with planned moments for instructor or student-led discussion.
- Instructor notes include discussion on how to lead students to a successful activity.
- Includes many extensions to challenge the most talented students.
- Microsoft® Word® files of student experiments and supporting materials on CD.
- Includes a site license.
- Instructions are written to support data collection in Logger *Pro* or LabQuest App.

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/phys-am**

Advanced Physics with Vernier – Mechanics lab book contains the following experiments:

	EXPERIMENT	SENSORS USED	REQUIRED VERNIER ACCESSORIES
1	Motion on an Incline	Motion Detector, Vernier Dynamics System	VDS
2	Error Analysis	Vernier Photogate	PF
3	Newton's First law	Motion Detector	VDS, PAD-VDS, BLK
4	Newton's Second Law	Vernier Photogate, Dual-Range Force Sensor	VDS, BLK, PF-CART, SPA, B-SPA
5	Newton's Third Law	(2) Dual-Range Force Sensors	VDS, BLK
6	Projectile Motion	Video Analysis in Logger *Pro*	
7	Energy Storage and Transfer (Elastic)	Dual-Range Force Sensor	VDS, BLK
8	Energy Storage and Transfer (Kinetic)	Vernier Photogate	VDS, BLK, PF-CART
9	Energy Storage and Transfer (Gravitational)		VDS, BLK
10A	Impulse and Momentum	Motion Detector, Dual-Range Force Sensor	VDS, BLK
10B	Impulse and Momentum	Vernier Photogate, Dual-Range Force Sensor	VDS, PF-CART, BLK
11A	Momentum and Collisions	(2) Motion Detectors	VDS
11B	Momentum and Collisions	(2) Vernier Photogates	VDS, (2) PF-CART
12A	Centripetal Acceleration	Vernier Photogate, Dual-Range Force Sensor	CFA
12B	Centripetal Acceleration	Vernier Photogate, Dual-Range Force Sensor	
13	Rotational Dynamics	Rotary Motion Sensor	AK-RMV
14	Conservation of Angular Momentum	Rotary Motion Sensor	AK-RMV
15	Simple Harmonic Motion - Mathematical Model	Motion Detector	SPRINGS
16	Simple Harmonic Motion - Kinematics and Dynamics	Motion Detector, Dual-Range Force Sensor	SPRINGS
17	Pendulum Periods	Rotary Motion Sensor	AK-RMV
18	Physical Pendulum	Rotary Motion Sensor	AK-RMV
19	Center of Mass	Video Analysis in Logger *Pro*	

Products for Advanced Physics – Mechanics

LabQuest 2 or LabQuest Mini	INTERFACE & SENSORS		CODE	LABQUEST 2	LABQUEST MINI
LABQUEST 2 CONNECTED SCIENCE SYSTEM	CHOOSE ONE	**LabQuest 2**	**LABQ2**	✔	—
Standalone, Computer, or Tablet		**LabQuest Mini (Computer)**	**LQ-MINI**	—	✔
	(2) Motion Detectors		MD-BTD	✔✔	✔✔
	(2) Vernier Photogates		VPG-BTD	✔✔	✔✔
	(2) Dual-Range Force Sensors		DFS-BTA	✔✔	✔✔
	Rotary Motion Sensor		RMV-BTD	✔	✔
Computer Only					

YOU MAY ALSO NEED:

Advanced Physics with Vernier – Mechanics **lab book** ORDER CODE **PHYS-AM**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.

Accessories listed below.

CENTRIPETAL FORCE APPARATUS

ORDER CODE
CFA

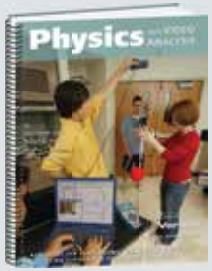
The Centripetal Force Apparatus allows you to investigate the relationship between centripetal force, angular velocity, mass, and radius. A force sensor measures the centripetal force exerted on a mass as it moves in a circle. A photogate can be used to measure the angular speed. Different masses can be added to the platform and positioned at variable radii. The platform can be driven by a falling mass. The apparatus also accommodates the Vernier Wireless Dynamics Sensor System to measure force, which provides the best set of data. Sensors are sold separately.
www.vernier.com/cfa

ADVANCED PHYSICS ACCESSORIES

Extensive use is made of these accessories in our *Advanced Physics – Mechanics* lab manual and they are highly recommended. Refer to the list of experiments on the opposite page.

Vernier Dynamics System or Motion Encoder System	VDS VDS-EC
Ultra Pulley Attachment	SPA
Pulley Bracket	B-SPA
Bumper and Launcher Kit	BLK
Cart Friction Pad	PAD-VDS
Picket Fence	PF
(2) Cart Picket Fences	PF-CART (x2)
Rotational Motion Accessory Kit	AK-RMV
Centripetal Force Apparatus	CFA
Spring Set	SPRINGS

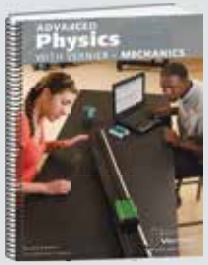
WE ALSO RECOMMEND:



Physics with Video Analysis **lab book**

ORDER CODE
PVA

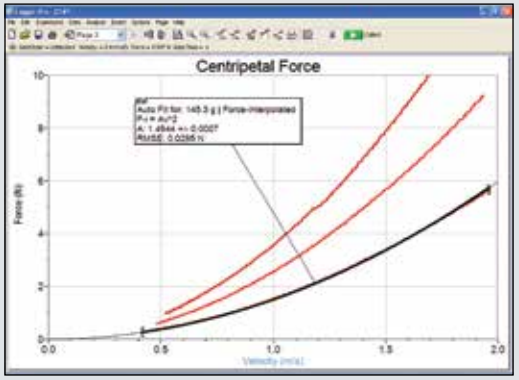
See page 102.



Advanced Physics with Vernier – Mechanics **lab book**

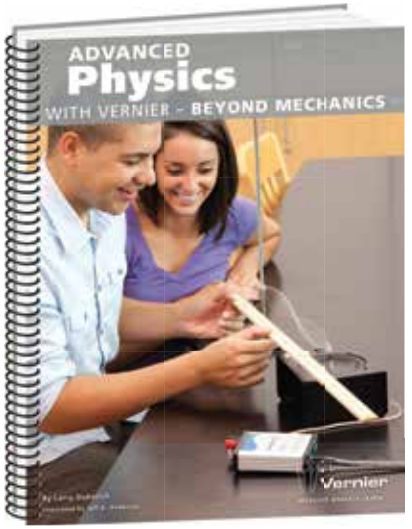
ORDER CODE
PHYS-AM

See page 86.



Centripetal force vs. velocity for three different masses, collected using the Vernier Centripetal Force Apparatus

MORE ONLINE – For FREE sample activities and videos go to **www.vernier.com/experiments**



BEYOND MECHANICS LAB BOOK

ORDER CODE **PHYS-ABM** GREAT VALUE!

Advanced Physics with Vernier – Beyond Mechanics is the second of a two-volume set of experiments for the more in-depth introductory physics course, such as college physics, AP Physics, or IB Physics. Included in this lab book

- Complete student experiments with a materials list, instructions for data collection on a computer or LabQuest, data tables, and questions
- Teacher Information section for each experiment with complete directions for setting up experiments, helpful hints, sample graphs, and data
- Word-processing files of the student sections on a CD so that any experiment may be easily edited to your specifications (Microsoft® Word® files)
- CD includes support material including videos and Logger *Pro* data-analysis files

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/phys-abm**

Advanced Physics with Vernier – Beyond Mechanics lab book contains the following experiments:

EXPERIMENT	SENSORS USED	REQUIRED VERNIER ACCESSORIES
1 Ideal Gas Law	Gas Pressure Sensor, Stainless Steel Temperature	
2 Heat Engines	Gas Pressure Sensor, Stainless Steel Temperature	
3 Standing Waves on a String	Power Amplifier	Power Amplifier Accessory Speaker
4 Standing Waves in a Tube	Microphone	
5 Doppler Effect with Water Waves	No probeware used	
6 Electrostatics	Charge Sensor	Electrostatics Kit
7 Coulomb's law	No probeware used	
8 Field Mapping	Differential Voltage Probe	Power Amplifier or Power Supply
9 Factors Affecting Resistance	Instrumentation Amplifier, Current Probe†	Power Amplifier or Power Supply, Resistivity Rod Set
10 Series and Parallel Circuits	Differential Voltage Probe, Current Probe	Vernier Circuit Board
11 Faraday's Law - Moving Magnet	Instrumentation Amplifier	
12 Faraday's Law - Alternating Current	Instrumentation Amplifier	Power Amplifier
13 RC and RL circuits	Differential Voltage Probe, Current Probe	Inductor, Vernier Circuit Board
14 RLC Circuits	Differential Voltage Probe, Current Probe	Power Amplifier, Inductor
15 Mirrors and Real Images		Optics Expansion Kit, Mirror Set*
16 Thin Lenses and Real Images		Optics Expansion Kit*
17 Thin Lenses and Virtual Images		Optics Expansion Kit*
18 Aperture and Depth of Field		Optics Expansion Kit*
19 Interference		Diffraction Apparatus*
20 Diffraction		Diffraction Apparatus*
21 Rydberg Constant	Red Tide Emission Spectrometer, Optical Fiber	Emission Tubes
22 Planck's Constant	Differential Voltage Probe	

* These accessories require the Vernier Dynamics track. (ORDER CODES VDS or TRACK, page 95) † Current Probe needed if using a conventional power supply.

Products for Advanced Physics – Beyond Mechanics

LabQuest 2 or LabQuest Mini	INTERFACE & SENSORS		CODE	LABQUEST 2	LABQUEST MINI
LABQUEST 2 CONNECTED SCIENCE SYSTEM	CHOOSE ONE	LabQuest 2	LABQ2	✔	—
		LabQuest Mini (computer)	LQ-MINI	—	✔
	Gas Pressure Sensor		GPS-BTA	✔	✔
	Stainless Steel Temperature Probe		TMP-BTA	✔	✔
	Power Amplifier		PAMP	✔	✔
	Microphone		MCA-BTA	✔	✔
	Charge Sensor		CRG-BTA	✔	✔
	Differential Voltage Probe		DVP-BTA	✔	✔
	Current Probe		DCP-BTA	✔	✔
	Instrumentation Amplifier		INA-BTA	✔	✔
	Emissions Spectrometer		VSP-EM	✔	✔
	Optical Fiber		VIS-NIR	✔	✔
	Diffraction Apparatus		DAK	✔	✔

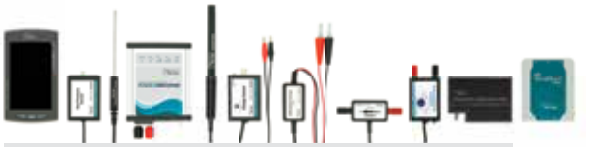
Standalone or Computer

Computer Only

SOFTWARE:

Logger *Pro* 3 software, ORDER CODE **LP**
See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW**
See page 17.



LABQUEST 2
LABQUEST MINI

DIFFRACTION APPARATUS

ORDER CODE
DAK

The Diffraction Apparatus consists of a laser light source, a collection of diffraction and interference slits, and a novel Linear Position Sensor and High Sensitivity Light Sensor. Map light intensity versus position for many slit geometries. Mounts on a Vernier Dynamics System Track (not included).

ADVANCED PHYSICS – BEYOND MECHANICS ACCESSORIES

Extensive use is made of these accessories in our *Advanced Physics with Vernier – Beyond Mechanics* lab manual, and they are highly recommended. Refer to the list of experiments on the opposite page.

Power Amplifier Accessory Speaker	PAAS-PAMP
Electrostatics Kit	ESK-CRG
Resistivity Rod Set	RRS
Vernier Circuit Board	VCB
Inductor	IND
Optics Expansion Kit	OEK
Mirror Set	M-OEK

a. Power Amplifier, ORDER CODE PAMP

The Vernier Power Amplifier allows you to drive loads with ±10 V and currents up to 1 A. Works with any waveform, including DC, sine, square, triangle, and sawtooth waveforms. The Power Amplifier can drive a variety of loads, including speakers, lamps, small DC motors, and RLC circuits. More on page 139.

b. Power Amplifier Accessory Speaker

ORDER CODE PAAS-PAMP

This kit includes a speaker and accessories used with the Vernier Power Amplifier to study mechanical waves and springs. The speaker contains a lightweight metal disc glued to the speaker cone. A drive post attached to the metal plate allows you to drive elastic materials such as strings and springs.

c. Rotary Motion Sensor

ORDER CODE RMV-BTD

Our Rotary Motion Sensor lets you monitor angular motion precisely and easily and is direction sensitive. Use it to collect angular displacement, angular velocity, and angular acceleration data.

d. Rotational Motion Accessory Kit

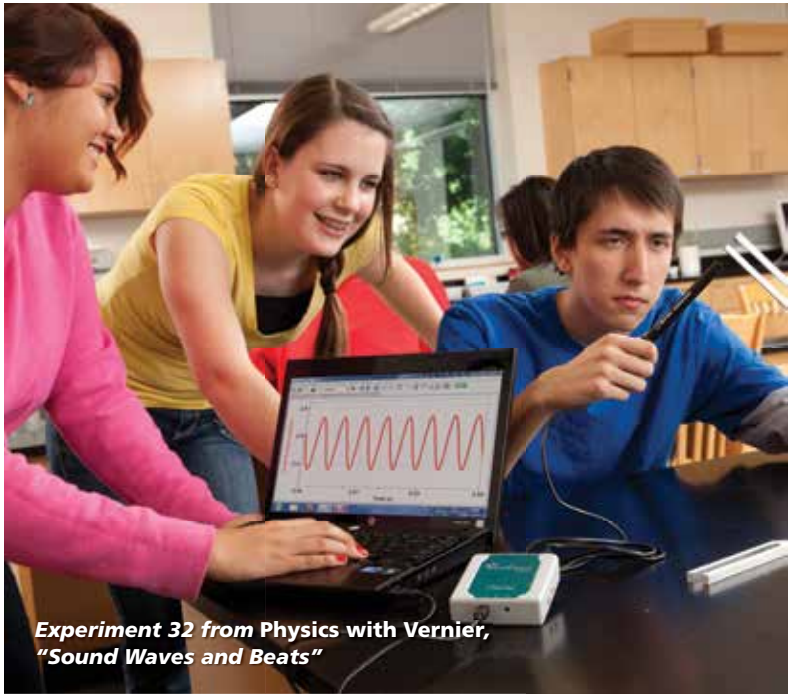
ORDER CODE AK-RMV

This accessory kit is used to study the motion of a physical pendulum; the rotational inertia of disks, rings, and point masses; and the conservation of angular momentum.

e. Force Plate*, ORDER CODE FP-BTA

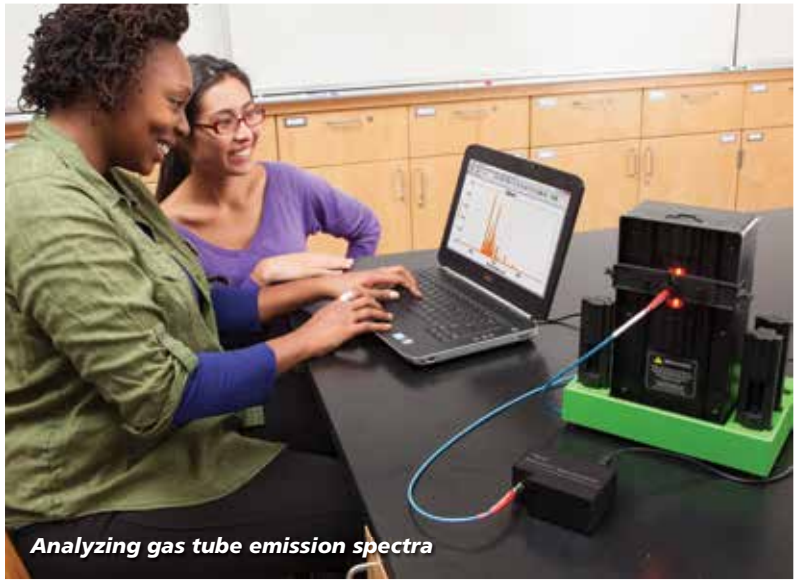
The Force Plate is a large force sensor—tough enough to jump on. About the size and shape of a bathroom scale, the Force Plate has two ranges: one reading up to 3500 N, and the other to 800 N. Two handles are included for pushing or pulling. Additional pairs of handles are available (ORDER CODE FP-HAN).

*Additional shipping charges may apply.



Experiment 32 from* Physics with Vernier, *"Sound Waves and Beats"

Exploring Newton's third law



Analyzing gas tube emission spectra

Spectrum Tube Carousel Power Supply

ORDER CODE **ST-CAR**

The Spectrum Tube Carousel Power Supply features the same ultra-safe, patented design of the Spectrum Tube Single Power Supply version but holds eight gas spectrum tubes simultaneously. You can quickly switch from one gas to another without handling the tubes. Includes a Spectrum Tube Fiber Optic Holder Carousel.

The Vernier Emissions Spectrometer and Optical Fiber are used here with the Spectrum Tube Carousel Power Supply.

f. NEW Vernier Emissions Spectrometer

ORDER CODE **VSP-EM**

This is the perfect tool to conduct emissions analysis. It connects directly to your computer or LabQuest with a standard USB cable and gives precise measurements over a range of 350–900 nm. Use the Vernier Emissions Spectrometer with or without an optical fiber to examine spectra of light bulbs, spectrum tubes, or the sun.

g. Optical Fiber, ORDER CODE VIS-NIR

This 400 µm diameter VIS-NIR Optical Fiber is used to pipe light from sources to a spectrometer.

h. Spectrum Tube Single Power Supply

ORDER CODE **ST-SPS**

The Spectrum Tube Single Power Supply provides an ultra-safe means of generating gas discharges. View the spectral lines with one of our spectrometers such as the Emissions Spectrometer described above. With no exposed high voltage, tubes are permanently enclosed in protective plastic carriers. There are no through-the-glass electrodes, so tubes are long lasting. One tube is energized at a time, and there are storage slots for six more tubes. Includes a Spectrum Tube Fiber Optic Holder. All tubes sold separately.

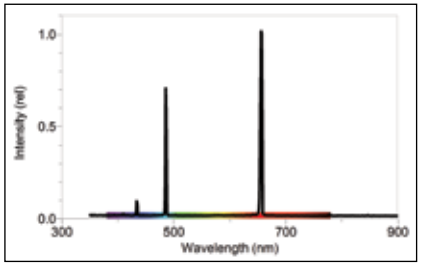
Spectrum Tube:

Hydrogen, ORDER CODE **ST-H**
Nitrogen, ORDER CODE **ST-N**
Helium, ORDER CODE **ST-HE**
Neon, ORDER CODE **ST-NE**
Carbon Dioxide, ORDER CODE **ST-CO2**
Air, ORDER CODE **ST-AIR**
Argon, ORDER CODE **ST-AR**

Spectrum Tube Power Supplies carry a two-year warranty.*

* Two years or 40 hours, whichever comes first, on the hydrogen tube. Two years or 100 hours, whichever comes first, on all other gas tubes.

f NEW



g

VIS-NIR Optical Fiber

h

a

b

c

a. Vernier Circuit Board, ORDER CODE VCB

The Vernier Circuit Board is a simple board that makes it easy to create circuits without a lot of loose components. Includes a resettable fuse, two powering options, resistors, capacitors, an LED, lamps, and binding posts to add your own components.

The Vernier Circuit Board is used in *Physics with Vernier* and *Advanced Physics with Vernier–Beyond Mechanics* experiments.

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b. Extech Digital DC Power Supply

ORDER CODE EXPS

The Extech Digital DC Power Supply has three outputs: adjustable 0–30 V at 0–3 A, fixed 5 V, and fixed 12 V. It provides constant current or constant voltage modes and has overload and short circuit protection. Binding post terminals are provided for the variable supply. Easy snap terminals are provided for the 5 V and 12 V outputs. The front panel contains digital voltage and current meters for the variable output, so you won't need additional metering in a typical experiment. The Extech Digital DC Power Supply comes with a one-year warranty.

The Extech Digital DC Power Supply is used in *Physics with Vernier* and *Advanced Physics with Vernier–Beyond Mechanics* experiments.

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c. Rotary Motion Motor Kit

ORDER CODE MK-RMV

The Rotary Motion Motor kit includes a small electric motor with pulley, rubber band belt, motor clip, and mounting screw. The motor can be attached to the Rotary Motion Sensor, and be used as an analog tachometer, or generator. You can also perform experiments that investigate motor efficiency in different conditions.

Studying Ohm's law using the Current Probe, Differential Voltage Probe, and the Vernier Circuit Board

Radiation Monitors and Lab Book

Vernier Radiation Monitor

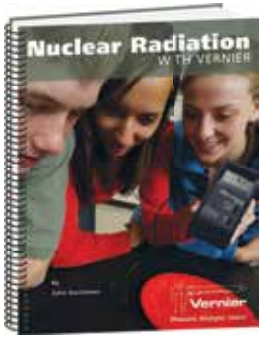
ORDER CODE **VRM-BTD**

The Vernier Radiation Monitor detects alpha, beta, gamma, and X-ray radiation using a Geiger-Mueller tube. Use the monitor for experiments in nuclear counting statistics, shielding, and decay rate measurements. No battery is required, as the Monitor gets power from the interface, such as LabQuest.

Digital Radiation Monitor

ORDER CODE **DRM-BTD**

The Digital Radiation Monitor consists of a Geiger-Mueller tube and a digital rate meter mounted in a small, rugged, plastic case with a digital meter. The unit is battery operated and can be used with or without a computer for measurement of alpha, beta, and gamma radiation. It can be used to explore radiation statistics and to measure the rate of nuclear decay.



Nuclear Radiation with Vernier lab book

by John Gastineau

ORDER CODE **NRV**

This book contains six experiments for data collection using our Radiation Monitors: Distance and Radiation; Counting Statistics; Lifetime Measurement; Background Radiation Sources; Radiation Shielding; and Alpha, Beta, and Gamma.

e. Charge Sensor, ORDER CODE CRG-BTA

The Charge Sensor is used as an electronic electroscope. An extremely high impedance voltage sensor with a 0.01 µF input capacitor makes possible quantitative measurements in many electrostatic experiments. The sensor has three operating ranges and a zeroing switch to discharge the input capacitor. For detailed specifications, see page 127.

f. Electrostatics Kit

ORDER CODE **ESK-CRG**

The Electrostatics Kit is an accessory for the Vernier Charge Sensor. This kit allows students to perform a range of experiments in electrostatics including the use of Faraday's Pail, quantitative and qualitative measurement of charge, charging by friction, charging by contact, and charging by induction. The kit includes

- Faraday Pail and cage
- Grounding plane
- Grounding wires and wrist strap
- Charge producers and proof plane
- Wool, vinyl, nylon rod, and PVC rod
- Cotton cloth

g. High-Voltage Electrostatics Kit

ORDER CODE **HVEK-CRG**

The High-Voltage Electrostatics Kit is an accessory for the Vernier Charge Sensor. Use it with a Faraday Pail and the Charge Sensor to investigate the distribution of charge on a sphere, transfer of charge on contact between two spheres, and charging by induction. The kit includes an electrostatics voltage source (output 750, 1500, 3000, 6000 VDC) and two conducting spheres. Extremely low output current makes this device safe for classroom use.

e

f

g

Vernier Dynamics Carts

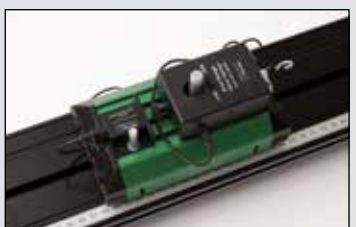
- They are perfect for kinematics and dynamics experiments.
- Easily attach a Dual-Range Force Sensor or our Wireless Dynamics Sensor System.
- Use them with our Motion Detector.
- Roll the cart down a ramp to study constant acceleration.
- Use two carts to study momentum conservation.
- With extremely low friction due to sealed bearings and machined wheels, our superior carts give very high quality data.
- Interchangeable magnetic and hook-and-pile end caps make it possible to do many experiments.
- The Plunger Cart has a spring-loaded plunger for consistent collisions, while the Standard Cart is similar, but has no plunger.
- Vernier carts are compatible with other common carts and tracks.

EXPERIMENTS FOR CART AND TRACK

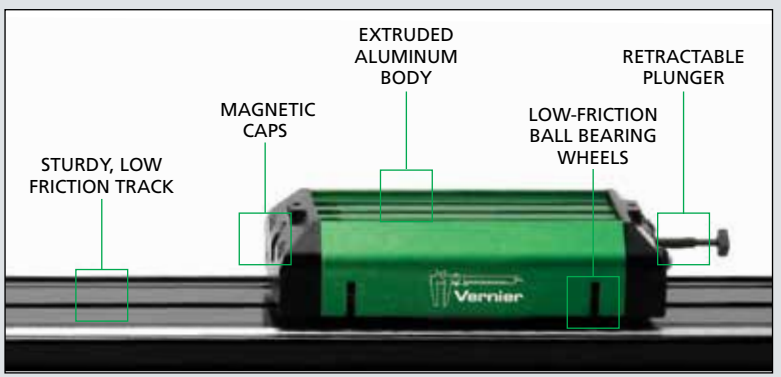
- Determining *g* on an Incline
- Newton's Second Law
- Momentum, Energy, and Collisions
- Impulse and Momentum
- Back and Forth Motion
- Cart on a Ramp
- Static and Kinetic Friction

These experiments can be found in our lab book Physics with Vernier *(see page 84). Additional experiments can be found in* Advanced Physics with Vernier–Mechanics *(see page 86).*

Dynamics Cart with WDSS attached



Dual-Range Force Sensor and Accelerometer



2.2 m Track

ORDER CODE
TRACK-LONG

For Wireless Dynamics Sensor System, see page 103.

BUMPER AND LAUNCHER KIT

ORDER CODE **BLK**

Contains accessories for experiments involving the Vernier Dual-Range Force Sensor, Vernier Wireless Dynamics Sensor System, and the Vernier Dynamics System. The accessories allow you to perform a wide range of experiments in kinematics and dynamics.

Vernier Bumper and Launcher Kit Includes

- One track bracket
- One dual-magnet bumper
- One DFS end mount screw
- Two magnetic bumpers
- Two rubber bumpers
- Two hoop bumpers
- Two clay holders
- One small brick of clay

Vernier Dynamics System

Use the Vernier Dynamics System to improve your kinematics and dynamics experiments. The Dynamics System is ideal for studying Newton's second law, acceleration on an inclined plane, momentum, and much more. Vernier sensors such as our Motion Detector, Dual-Range Force Sensor, Wireless Dynamics Sensor System, Photogate, and Accelerometer easily attach to the Dynamics System. Make the most of your track by adding the Vernier Optics Expansion Kit for studying optics. See pp. 98–99.

ORDER CODE
VDS

Vernier Dynamics System Includes

- Combination 1.2 m Dynamics Track/Optics Bench
- Standard Cart with magnetic and hook-and-pile end caps
- Plunger Cart with magnetic and hook-and-pile end caps
- Mass – 500 g
- Adjustable End Stop
- Two Adjustable Two Foot Levelers
- Motion Detector Bracket
- Two Photogate Brackets
- Rod Clamp

VERNIER DYNAMICS SYSTEM WITH LONG TRACK

ORDER CODE **VDS-LONG**

The long-track version includes the same carts and accessories as the standard system but substitutes a 2.2 m Track for the 1.2 m Track.

NEW VERNIER MOTION ENCODER SYSTEM

ORDER CODE **VDS-EC** See pp. 96–97.

Cart Fan

ORDER CODE
FAN-VDS

Friction Pad

ORDER CODE
PAD-VDS

Pulley Bracket

ORDER CODE
B-SPA

Ultra Pulley Attachment

ORDER CODE
SPA

MORE DYNAMICS SYSTEM ACCESSORIES

Additional 1.2 m Track, ORDER CODE **TRACK**
2.2 m Track, ORDER CODE **TRACK-LONG**
Standard Cart, ORDER CODE **CART-S**
Plunger Cart, ORDER CODE **CART-P**
Cart Picket Fence, ORDER CODE **PF-CART**

Vernier Motion Encoder System*

NEW Motion Sensing that Just Works

The Motion Encoder Cart replaces the ultrasonic Motion Detector when used for dynamics cart-on-track activities. An optical sensor beneath the dynamics cart senses the passage of the cart over a marked strip on the track. The position information is sent as an encoded IR signal to a receiver at the track's end. By avoiding the possibility of stray sound reflections, this optical-only system provides excellent, repeatable, and noise-resistant motion data.

Because the position information is relayed by a narrow IR beam, multiple Motion Encoder Carts can be used in a single lab. Two can even be used at a time on a single track, allowing students to study collisions.

If you have ever been frustrated by the need to tweak the alignment of a motion detector, you will be pleased by the data your students collect using the Vernier Motion Encoder System.

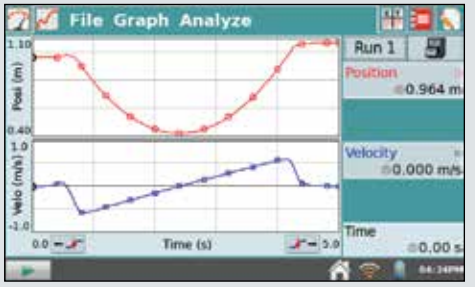
* Patent Pending

PRODUCT DETAILS

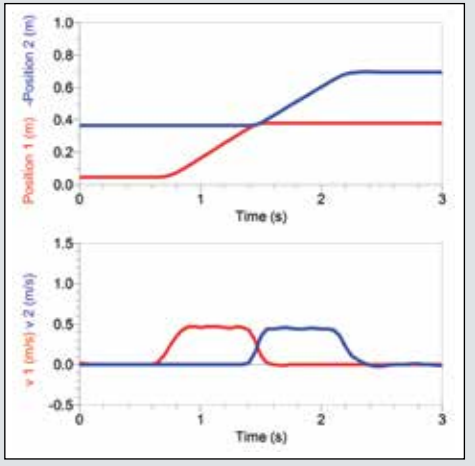
- Resolution: 1 mm
- Max useful data rate: 30 Hz
- Supports: 1.2 and 2.2 m tracks

SENSOR REQUIREMENTS

The sensor portion of the Vernier Motion Encoder System, the Motion Encoder Cart Receiver, requires an interface to function. It is compatible with the original LabQuest, LabQuest 2, LabQuest Mini, and LabPro.



The Motion Encoder Cart on a ramp displays uniform acceleration.



Using two Motion Encoder Carts simultaneously in a elastic collision

Studying a cart under constant acceleration using a Vernier Motion Encoder System

HOW TO DETERMINE WHICH PARTS TO BUY

You have no carts and tracks at all	Buy the Vernier Motion Encoder System (VDS-EC). This gets you all the parts in one order.
You have a Vernier Dynamics System already	Buy the Motion Encoder Upgrade Kit (MEU-VDS). With a few minutes of work you can convert an existing cart to an Encoder Cart.
You would rather just get an additional cart	Buy the Motion Encoder Cart and Receiver (MEC-VDS) to add to your existing Vernier Dynamics System.

NEW Vernier Motion Encoder System

ORDER CODE **VDS-EC***

The Vernier Motion Encoder System is a complete dynamics system with all the parts of the standard Vernier Dynamics System, but with a Motion Encoder Cart substituted for the standard cart. A Motion Encoder Receiver is included.

Vernier Motion Encoder System includes

- Combination 1.2 m Dynamics Track/Optics Bench
- Motion Encoder Cart with magnetic and hook-and-pile end caps
- Motion Encoder Receiver
- Plunger Cart with magnetic and hook-and-pile end caps
- Mass – 500 g
- Adjustable End Stop
- Two Adjustable Two Foot Levelers
- Motion Detector Bracket
- Two Photogate Brackets

NEW Vernier Motion Encoder System with Long Track

ORDER CODE **VDS-EC-LONG***

This system includes the parts listed above, but substitutes a 2.2 m Track for the 1.2 m Track.

* Additional shipping charges may apply due to weight.

UPGRADE KITS

NEW Motion Encoder Upgrade Kit

ORDER CODE **MEU-VDS**

The Motion Encoder Upgrade Kit is for owners of the Vernier Dynamics System. The kit allows the user to upgrade one existing cart to a Motion Encoder Cart and includes the Motion Encoder Receiver and a Motion Encoder Track Strip. One time assembly required to modify your cart.

NEW Motion Encoder Cart and Receiver

ORDER CODE **MEC-VDS**

The Motion Encoder Cart and Receiver is for owners of the Vernier Dynamics System who want to add a complete Motion Encoder Cart. No assembly is required. It includes a fully assembled Motion Encoder Cart, as well as the Motion Encoder Receiver and a Motion Encoder Track Strip.

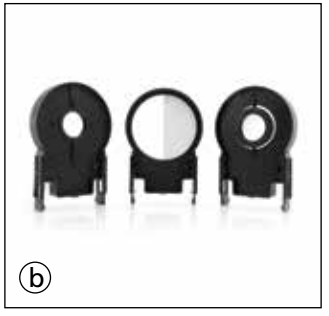
MORE ONLINE – www.vernier.com/motion-encoder-system

Motion Encoder Cart

Motion Encoder Receiver

Track

Viewing an inverted image using a single thin lens from the Optics Expansion Kit mounted on the Vernier Dynamics System Track



Vernier Optics System

Expand the use of your Vernier Dynamics System by adding these optics products.

ORDER CODE **OEK**

a. Optics Expansion Kit, ORDER CODE OEK

Add the Vernier Optics Expansion Kit to your dynamics track to conduct optics experiments, such as image formation with lenses and light intensity *vs.* distance. You can even use the kit to build a basic telescope.

Vernier Optics Expansion Kit includes

- Three lens holders with bases
- 100 mm converging lens
- 200 mm converging lens
- -150 mm diverging lens
- Screen, holder, and base
- Combination luminous and point light source
- Light sensor holder
- Aperture screen
- Power Supply

The Optics Expansion Kit extends the capabilities of the Vernier Dynamics System track (sold separately).

Download free sample experiments online: **www.vernier.com/oek**

The Optics Expansion Kit is also used in *Physics with Vernier* and *Advanced Physics with Vernier—Beyond Mechanics* experiments.

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b. Mirror Set, ORDER CODE M-OEK

The Mirror Set for the Optics Expansion Kit extends the kit to allow students to easily study image formation by concave and convex mirrors. Includes a concave mirror, a convex mirror, and a half screen for viewing images formed by the mirrors. Requires components from the Optics Expansion Kit for use.

---

c. Combination 1.2 m Track/Optics Bench, ORDER CODE TRACK

The Combination Dynamics Track and Optical Bench is black anodized aluminum and includes a metric scale. Extremely rigid, this 1.2 meter track will not sag under use. The track includes two adjustable levelers.

d. Color Mixer, ORDER CODE CM-OEK

The Color Mixer accessory for the Vernier Dynamics System consists of a three-color LED source, a lens, and a screen. These all attach to a Vernier Track and can be used to study the mixing of red, blue, and green light by additive and subtractive mixing. These simple experiments show how modern computer and television displays work.

The intensity of each LED can be controlled easily, demonstrating color addition. For subtraction, you can create shadows by placing objects in the light path.

The Color Mixer Kit extends the capabilities of the Vernier Dynamics System track (sold separately).

MORE ONLINE – Download a free sample experiment:
www.vernier.com/cm-oek

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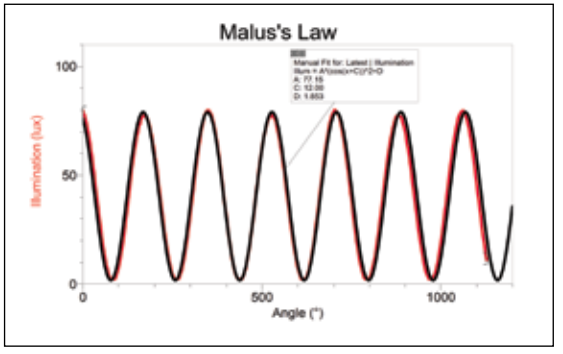
e. Polarizer/Analyzer Set, ORDER CODE PAK-OEK

The Polarizer/Analyzer Set allows students to study light polarization, doing experiments such as Malus's law. The set consists of three adjustable linear polarizers, one of which includes attachment points for the Vernier Rotary Motion Sensor.

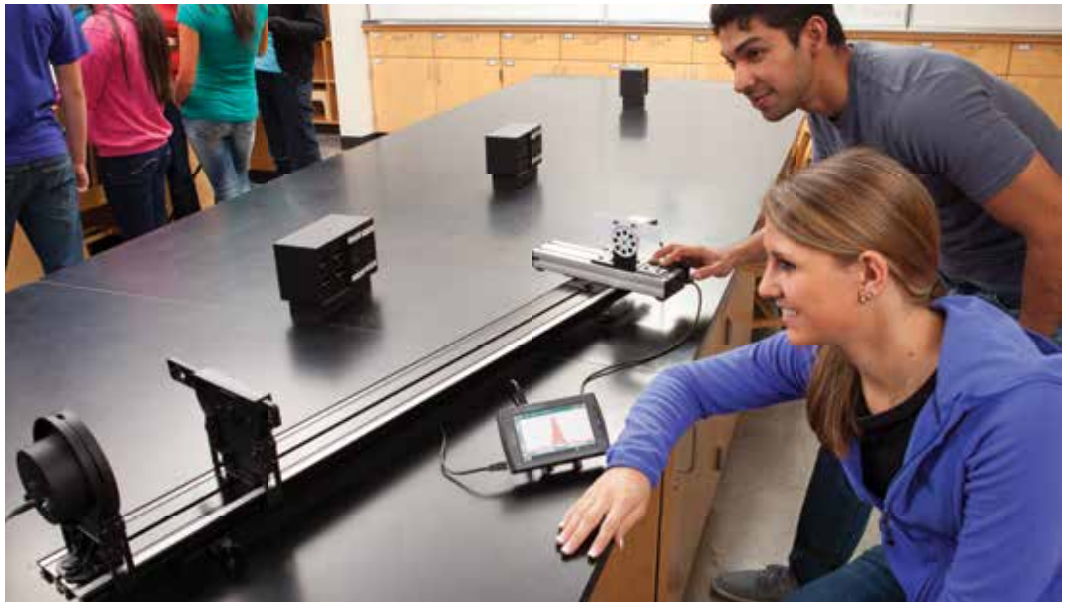
A complete experiment requires the Vernier Dynamics System Track, a Vernier Light Sensor, and the Light Sensor Holder and Light Source from the Optics Expansion Kit (all sold separately). Optionally, a Vernier Rotary Motion Sensor allows sensor-based angle measurement.

The Polarizer/Analyzer Set is used in *Physics with Vernier* experiments.

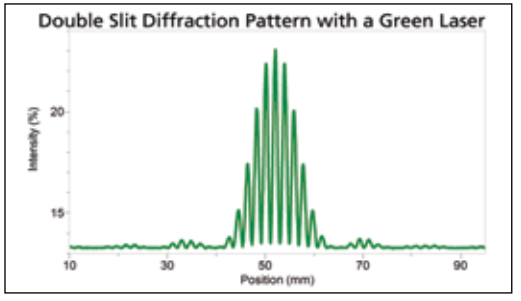
Mixing equal intensities of red, blue, and green to get white light



These data show a basic Malus's law experiment done with the Polarizer/Analyzer Set.



Collecting intensity vs. position data for a diffraction pattern



Double-slit diffraction pattern with 0.04 mm slits separated by 0.25 mm, 532 nm laser wavelength

Diffraction Apparatus

ORDER CODE **DAK**

a. Diffraction Apparatus, ORDER CODE DAK

The Diffraction Apparatus lets students create, view, and measure diffraction and interference patterns. The included Red Diffraction Laser provides a clean monochromatic light source. Slits are made by depositing metal film on glass, creating extraordinarily clean slits with fully opaque blocking areas. These high-precision slits cast clean diffraction and interference patterns, ideal for quantitative matching of intensity *vs.* position predictions.

The Linear Position Sensor and High Sensitivity Light Sensor completes the Diffraction Apparatus. In order to provide excellent spatial resolution, a selectable entrance aperture restricts the width of the pattern viewed by the High Sensitivity Light Sensor. The light sensor has three ranges, allowing the study of fine details or gross features of patterns. To measure position, the light sensor is mounted on a novel Linear Position Sensor.

This position sensor uses a precision optical encoder to measure translation with better than a 50 micron resolution. Since it is optically based, without gears or racks, it has zero backlash.

Data collection is performed by choosing a slit, directing the laser through the slit, and choosing an entrance aperture for the light sensor. Both the light sensor and position sensor connect to your interface. The light sensor is moved by hand over a 150 mm distance, tracing out the diffraction pattern.

The Diffraction Apparatus requires a Combination 1.2 m Track/Optics Bench, individually or part of the Vernier Dynamics System. An optional Green Diffraction Laser is also available, so that the effect of wavelength on the pattern can be measured.

---

b. Green Diffraction Laser, ORDER CODE GDL-DAK

The Green Diffraction Laser is an optional accessory for the Diffraction Apparatus. Operating at 532 nm, it allows students to see and measure how diffraction patterns depend on light wavelength.

Note that the Green Laser does not include its own power supply. It uses the same power supply as the Red Diffraction Laser, which is the same as the LabQuest power supply.

Projectile Launcher

ORDER CODE **VPL**

a. Projectile Launcher, ORDER CODE VPL

Use the Vernier Projectile Launcher to investigate important concepts in two-dimensional kinematics. Launch steel balls at angles between 0 and 70 degrees and up to a distance of 2.5 m. A unique pneumatic launching system provides excellent repeatability and allows you to adjust the launch speed. Built-in photogates and angle markings provide easy and accurate measurement of the ball's launch velocity, allowing for precise quantitative analysis of projectile motion.

Includes: launcher, six steel balls, hand pump, two pairs of goggles, level, roll of waxed marking paper, photogate cable

Product Specifications

Launch angle: 0 to 70 degrees
Launch speed: 0-6 m/s
Launch height: 146 mm
Internal photogate interval: 50 mm
Steel ball mass: 21.8 g
Steel ball diameter: 17.5 mm

---

b. Projectile Stop, ORDER CODE PS-VPL

The Projectile Stop has one job: to keep the projectiles from the Vernier Projectile Launcher from rolling out of sight. Place the Projectile Stop in the launch line, beyond the landing site, and the projectile will be caught.

---

c. Time of Flight Pad, ORDER CODE TOF-VPL

The Time of Flight Pad is used to precisely measure how long a projectile has been in motion. Use it with the Vernier Projectile Launcher and a Vernier interface to determine the launch speed of a projectile, along with the time the projectile is in flight.

---

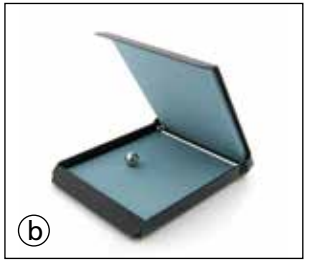
d. Independence of Motion Accessory, ORDER CODE IOM-VPL

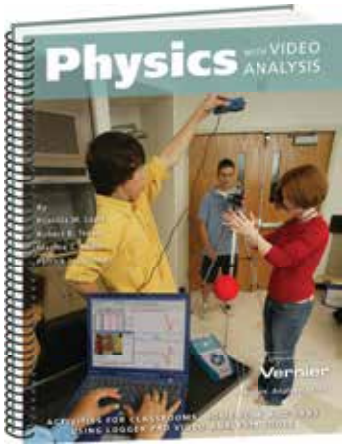
The Independence of Motion Accessory enables the Vernier Projectile Launcher to perform the classic experiment where one ball is dropped as another is projected horizontally. The balls strike the floor simultaneously.

The Projectile Launcher and accessories are used in *Physics with Vernier* experiments.

MORE ONLINE – For more information on the Projectile Launcher, visit **www.vernier.com/vpl**

Measuring the time of flight of a projectile





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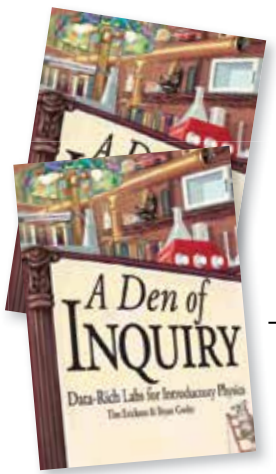


b

c

a. *Physics with Video Analysis*

ORDER CODE **PVA**

by Priscilla Laws, Robert Teese, Maxine Willis, and Patrick Cooney

Physics with Video Analysis contains a wide selection of Logger *Pro* video analysis activities for introductory physics at either the high school or college level. Topics include kinematics, dynamics, circuits, sound, electrostatics, and more. Includes a CD with professionally made videos, student activities, solutions, and Logger *Pro* setup files.

MORE ONLINE – Free sample activities and videos are available on our web site at **www.vernier.com/livephoto**

A Den of Inquiry *by Tim Erikson*

b. Volume 1, ORDER CODE DEN

Fifteen labs for introductory physics. These labs emphasize data analysis and mathematical modeling, but they do not require sensors. The book includes files and instructions for Logger *Pro* and for Fathom. Each lab includes teacher notes and black line masters.

c. Volume 2, ORDER CODE DEN2

Sixteen sensor-based activities for introductory physics. Topics include kinematics, mechanics and energy; activities emphasize data analysis and modeling. Either Fathom 2.1 or Logger *Pro* software can be used.

Additional physics curriculum

For details on the following, go to **www.vernier.com/books** and click on Physics.

- Tools for Scientific Thinking
- RealTime Physics Activity Guides
- Workshop Physics
- Understanding Physics
- Interactive Lecture Demonstrations

VERNIER VIDEO PHYSICS

Vernier Video Physics brings video analysis to iPad, iPhone, and iPod touch. Track an object, set the scale, and see graphs of trajectory, position, and velocity. See page 26 for more information.

AWARDS of EXCELLENCE winner! TECH LEARNING

Available on the App Store

//CODiE// 2012 SIIA CODIE FINALIST

AMUSEMENT PARK PHYSICS *by Clarence Bakken*

ORDER CODE **AMPK**

The book, *Amusement Park Physics*, is an excellent resource for teachers who want their students to connect their experiences at an amusement park to the physics concepts studied in class. The book explains how the instruments used to collect data, including electronic sensors, work on a conceptual level. A key portion of the book discusses taking your class to the amusement park and includes sample lab sheets and problem sets.

DATA VEST, ORDER CODE DV

The Data Vest makes hands-free data collection at an amusement park or playground easy. The vest has a front pouch for the LabQuest, LabPro, CBL 2, or the Wireless Dynamics Sensor System. It has two inside pockets for the sensors and side straps to hold the vest in place.

ACTIVITY BASED PHYSICS HIGH SCHOOL E-DITION

ORDER CODE **ABP-E, Download Only**

The *Activity Based Physics* High School e-dition is a special pre-college edition of physics curriculum from the Wiley Physics Suite, including *RealTime Physics*, *Workshop Physics*, and *Interactive Lecture Demonstrations*. See **www.vernier.com/abp-e**

A COMPLETELY WIRELESS SENSOR SYSTEM

The Wireless Dynamics Sensor System combines a 3-axis accelerometer, force sensor, and altimeter into one unit that communicates wirelessly with your computer via Bluetooth®. You can also use it as a standalone data logger. It's more than just a wireless sensor; it's a complete data-collection system completely free of friction due to cables. The Centripetal Force Apparatus (page 87) is significantly enhanced by using this wireless sensor.

Wireless Dynamics Sensor System

ORDER CODE **WDSS**

Includes a rechargeable battery* and charger, bumpers for collisions, hooks for mounting the unit in different positions, mounting hardware for Vernier and other dynamics carts, and a manual.

YOU ALSO NEED:

Computer use
- Logger *Pro* 3 software
- Either compatible built-in Bluetooth or Bluetooth USB Dongle

LabQuest use
- LabQuest 2
  or
- Original LabQuest with Bluetooth USB Dongle

Bluetooth USB Dongle Radio

ORDER CODE **BLUE-USB**

Each computer used with a WDSS must have a Bluetooth radio. This convenient USB dongle adds Bluetooth capabilities to any original LabQuest, Windows XP SP2, Vista, Windows 7, or Mac OS X 10.4 or newer computer that lacks Bluetooth. It can also be used with an original LabQuest to add Bluetooth capabilities to LabQuest (requires LabQuest App 1.5, or newer).

* The Wireless Dynamics Sensor System battery carries a one-year warranty.

Wireless Dynamics Sensor System

Altimeter
Record changes in altitude for roller-coaster physics.

3-Axis Accelerometer
Three orthogonally mounted sensors let you measure acceleration in all directions.

Data-Collection Status

Communication Status

On-Board Memory
Retains data even after the unit is turned off.

Multiple Mounting Options
Mount the device in almost any orientation using standard hardware.

Battery Charging Indicator

Start/Stop Collection Button
Simple, one-button operation allows you to start and stop data collection when away from the computer.

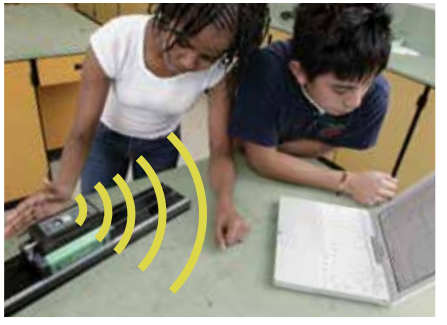
Force Sensor
Custom load cell provides accurate, repeatable results.

Additional Hook
Allows the device to be mounted in-line for tension and pendulum experiments.

ORDER CODE
WDSS

- Measures acceleration, force, and altitude
- Wireless real-time data collection
- Works as a standalone data logger

WIRELESS DYNAMICS SENSOR SYSTEM
FORCE • ACCELERATION • ALTITUDE



SPECIFICATIONS
INTERNAL DATA STORAGE CAPACITY: 240,000 points
MAXIMUM SAMPLING RATE: 1000 samples/second

FORCE
RANGE: ±50 N
RESOLUTION: 0.006 N (<10 N)
0.03 N (>10 N)

ACCELEROMETERS
(FOR EACH AXIS)
RANGE: ±50 m/s² (±5 g)
RESOLUTION: 0.04 m/s²

ALTIMETER
ALTITUDE CHANGE RANGE: +/-200 m
RESOLUTION: 1 m

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Want to save time? Start with Vernier lab books. Aligned to state and national science standards, our lab books contain experiments for LabQuest and computers.

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Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

LabQuest Mini – LabQuest Mini is a low-cost computer solution with five sensor ports. More details on pp. 18–19.

3 CHOOSE YOUR SENSORS

Our Science Department Deluxe Package includes the most frequently used sensors for a variety of science courses to support your entire department.

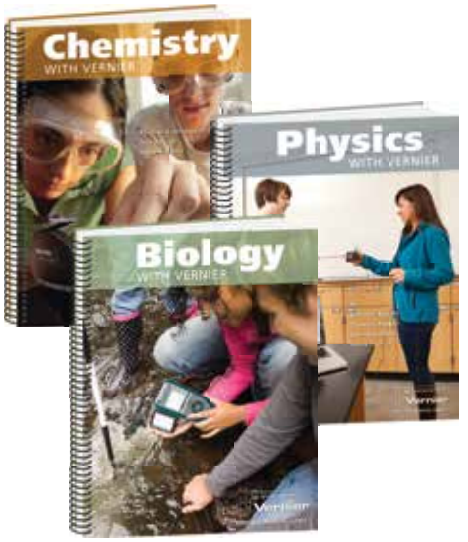
For a complete list of sensors by subject:

Biology page 33
Chemistry pp. 47, 49
Earth Science page 57
Environmental Science page 69
Middle School Science page 77
Physical Science page 81
Physics pp. 85, 87, 89
Water Quality page 107

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.



SCIENCE LAB BOOKS

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- Ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD, unless otherwise noted
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/labs**

See pp. 108–115 for more information on all of our lab books.

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	Stainless Steel Temperature Probe	Light Sensor	Voltage Probe	Motion Detector	Dual-Range Force Sensor	Microphone	Low-g Accelerometer	Magnetic Field Sensor	Gas Pressure Sensor	pH Sensor	Conductivity Probe	Colorimeter	Optical DO Probe	CO_2 Gas Sensor	Hand-Grip Heart Rate Monitor
Biology	✔								✔	✔	✔	✔	✔	✔	✔
Chemistry	✔		✔						✔	✔	✔	✔			
Earth Science	✔	✔	✔	✔				✔		✔	✔				
Environmental	✔	✔	✔							✔	✔		✔	✔	
Math	✔	✔	✔	✔	✔	✔			✔	✔					
Middle School	✔	✔	✔	✔	✔			✔	✔	✔	✔				✔
Physical Science	✔	✔	✔	✔	✔			✔	✔	✔	✔				
Physics	✔	✔	✔	✔	✔	✔	✔	✔							
Water Quality	✔									✔	✔	✔	✔		

For more information visit **www.vernier.com/probes**

WHY USE PROBEWARE IN SCIENCE?

Hands-on science using Vernier technology gets students excited about science and deepens their understanding of complex concepts. It gives students the tools to analyze data and think like real scientists. Request our **White Paper** at **www.vernier.com/whitepaper**

Science Department LabQuest 2 and LabQuest Mini Packages

Purchase one package per lab group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Deluxe Package LQ2-SCI-ODX
Vernier LabQuest 2 Interface	**LABQ2**	✔
Stainless Steel Temperature Probe	TMP-BTA	✔
Light Sensor	LS-BTA	✔
Voltage Probe	VP-BTA	✔
Motion Detector	MD-BTD	✔
Dual-Range Force Sensor	DFS-BTA	✔
Microphone	MCA-BTA	✔
Low-g Accelerometer	LGA-BTA	✔
Magnetic Field Sensor	MG-BTA	✔
pH Sensor	PH-BTA	✔
Gas Pressure Sensor	GPS-BTA	✔
Conductivity Probe	CON-BTA	✔
Vernier Optical DO Probe	ODO-BTA	✔
Colorimeter	COL-BTA	✔
CO_2 Gas Sensor	CO2-BTA	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔

DELUXE

YOU MAY ALSO NEED:

Lab books, see pp. 108–115.

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW.** See page 17.

LABQUEST 2 SCIENCE DEPARTMENT PACKAGE

LabQuest Mini

Computer Only

LABQUEST MINI INTERFACE & SENSORS	CODE	Deluxe Package LM-SCI-ODX
Vernier LabQuest Mini Interface	**LQ-MINI**	✔
Stainless Steel Temperature Probe	TMP-BTA	✔
Light Sensor	LS-BTA	✔
Voltage Probe	VP-BTA	✔
Motion Detector	MD-BTD	✔
Dual-Range Force Sensor	DFS-BTA	✔
Microphone	MCA-BTA	✔
Low-g Accelerometer	LGA-BTA	✔
Magnetic Field Sensor	MG-BTA	✔
pH Sensor	PH-BTA	✔
Gas Pressure Sensor	GPS-BTA	✔
Conductivity Probe	CON-BTA	✔
Vernier Optical DO Probe	ODO-BTA	✔
Colorimeter	COL-BTA	✔
CO_2 Gas Sensor	CO2-BTA	✔
Hand-Grip Heart Rate Monitor	HGH-BTA	✔

DELUXE

YOU MAY ALSO NEED:

Lab books, see pp. 108–115.

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25 for details.

LABQUEST MINI SCIENCE DEPARTMENT PACKAGE

FOR TI CALCULATOR-BASED DATA COLLECTION: see pp. 117–123

1 IT ALL STARTS WITH CURRICULUM

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Vernier LabQuest 2 – LabQuest 2 is our color, touch-screen interface. Use it as a standalone device or as a computer interface. More details on pp. 11–16.

3 CHOOSE YOUR SENSORS

Choose from Vernier's recommended packages or build your own from our list of sensors.

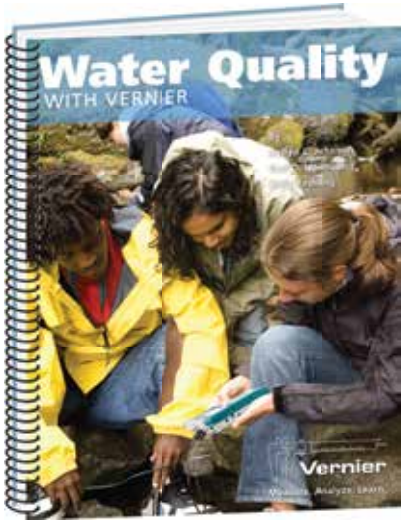
Our Deluxe Package contains all the sensors needed to perform every experiment in our water quality lab book.

4 RECOMMENDED SOFTWARE

Logger *Pro* – This award-winning software is the best value around! Includes a site license for all computers in your school or your college department, as well as students' personal computers. See pp. 22–25 for details.

LabQuest Viewer – Project your LabQuest screen via Wi-Fi or remotely monitor student progress by viewing student LabQuests. More details on page 17.

Build custom packages online at www.vernier.com/guide



WATER QUALITY LAB BOOK

ORDER CODE **WQV** GREAT VALUE!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book you will receive

- Essential teacher information
- 16 ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, computer, and calculator versions on CD
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/wqv**

Water Quality with Vernier lab book contains the following water quality tests:

☐ ☐ **USING A DISSOLVED OXYGEN PROBE**
- Dissolved Oxygen
- Biochemical Oxygen Demand

☐ ☐ **USING A TEMPERATURE PROBE**
- Temperature

☐ ☐ **USING A pH SENSOR**
- pH
- Alkalinity

☐ ☐ **USING A TURBIDITY SENSOR**
- Turbidity

☐ ☐ **USING A CONDUCTIVITY PROBE**
- Total Dissolved Solids
- Chloride and Salinity

☐ ☐ **USING A COLORIMETER**
- Phosphates, Ortho- and Total
- Nitrate

☐ ☐ **USING A FLOW RATE SENSOR**
- Flow Rate and Stream Discharge

☐ ☐ **USING ION-SELECTIVE ELECTRODES****
- Nitrate
- Ammonium Nitrogen
- Calcium and Water Hardness
- Chloride and Salinity

WATER TESTS REQUIRING NO SENSOR
- Total Solids
- Fecal Coliform
- Total Water Hardness

WATER-QUALITY INDEX TESTS
- Temperature
- pH
- Turbidity
- Total Solids
- Dissolved Oxygen
- Biochemical Oxygen Demand
- Phosphates, Ortho- and Total
- Fecal Coliform
- Nitrate

☐ STARTER PACKAGES ☐ DELUXE PACKAGES

** Ion-Selective Electrodes require good chemical technique and careful calibration to obtain accurate results. They are not recommended for middle school or elementary students.

AP Many of the experiments in our water quality lab book are the perfect complement to labs for AP* Environmental Science. See **www.vernier.com/ap**

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GLOBE® AND VERNIER

Use Vernier sensors to collect GLOBE data! The following Vernier sensors meet GLOBE specifications:

- Dissolved Oxygen Probe
- pH Sensor
- Stainless Steel Temperature Probe
- Conductivity Probe
- Barometer
- Relative Humidity Sensor
- Turbidity Sensor
- Salinity Sensor
- Nitrate Ion-Selective Electrode
- Soil Moisture Sensor

To learn more about Vernier and GLOBE, see **www.vernier.com/globe**

Water Quality LabQuest 2 Packages

Purchase one package per lab group (2–4 students) or BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

LabQuest 2

Standalone, Computer, or Tablet

LABQUEST 2 INTERFACE & SENSORS	CODE	Starter Package LQ2-WQ-OST	Deluxe Package LQ2-WQ-ODX
Vernier LabQuest 2 Interface	**LABQ2**	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
pH Sensor	PH-BTA	✔	✔
Vernier Optical DO Probe*	ODO-BTA	✔	✔
Conductivity Probe	CON-BTA	✔	✔
Turbidity Sensor	TRB-BTA	✔	✔
Colorimeter	COL-BTA		✔
Flow Rate Sensor	FLO-BTA		✔
Nitrate Ion-Selective Electrode	NO3-BTA		✔
Calcium Ion-Selective Electrode	CA-BTA		✔
Chloride Ion-Selective Electrode	CL-BTA		✔
Ammonium Ion-Selective Electrode	NH4-BTA		✔
LABQUEST 2	WATER QUALITY PACKAGE		

YOU MAY ALSO NEED:

Water Quality with Vernier **lab book,** ORDER CODE **WQV**

Logger *Pro* 3 software, ORDER CODE **LP.** See pp. 22–25.

LabQuest Viewer software, ORDER CODE **LQ-VIEW.** See page 17.

*Deluxe packages containing the Dissolved Oxygen Probe are available online.

MORE PRODUCTS FOR WATER QUALITY TESTING

Salinity Sensor

ORDER CODE **SAL-BTA**

Easily and precisely measures the total dissolved salt content in ocean or brackish water.

Extra-Long Temperature Probe

ORDER CODE **TPL-BTA**

This probe has a 30-meter (100 ft) cable. It measures temperature at various depths in lakes and streams.

Water Depth Sampler

ORDER CODE **WDS**

Use this device to collect water samples from any desired lake depth. A 50-foot nylon drop cord is included.

Vernier Optical DO Probe

ORDER CODE **ODO-BTA**

Students can now measure the concentration of dissolved oxygen in water quickly and easily with the new Vernier Optical DO Probe. This probe can be used to measure dissolved oxygen concentration in surface water or to perform a wide variety of experiments to determine changes in dissolved oxygen levels, one of the primary indicators of the quality of an aquatic environment.

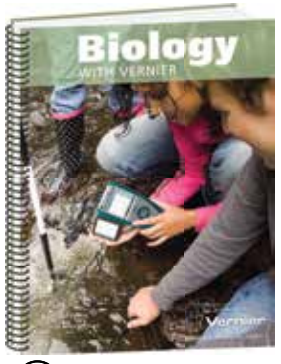
- Plug-and-play technology—no filling solution, warm-up time, calibration, or stirring necessary
- Built-in temperature and pressure compensation
- Easy maintenance
- Switch setting allows units of mg/L or % saturation

For more details see page 39.

Enhance Your Curriculum with Vernier Lab Books

Buy just one copy per classroom, photocopy the labs, or print them from the included CD.

Each book includes a CD with word-processing files of the student instructions for data collection using Logger *Pro* (computer), LabQuest App (LabQuest as a standalone device), and EasyData (TI graphing calculators), unless otherwise noted.



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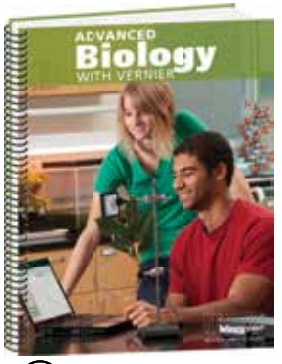

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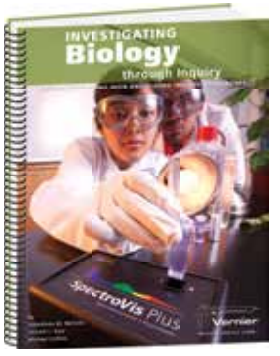

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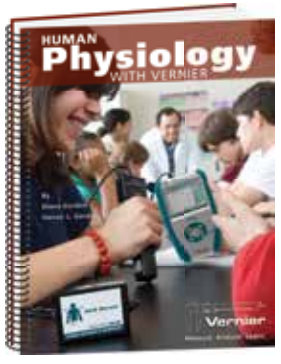

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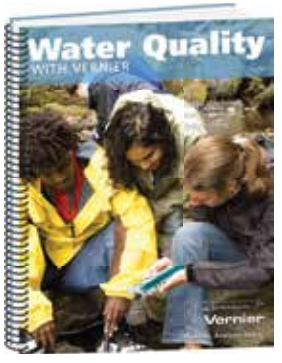

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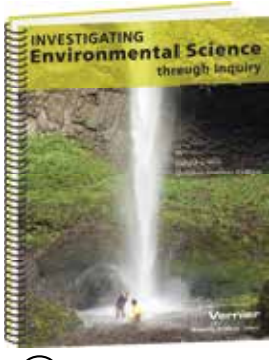

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a. *Biology with Vernier,* ORDER CODE **BWV**
Highly recommended for first-year biology. This book contains 31 experiments in cell respiration, photosynthesis, membrane diffusion, osmosis, human physiology, transpiration, fermentation, and other important biology concepts. See page 28.

b. *Advanced Biology with Vernier,* ORDER CODE **BIO-A**
Highly recommended for second-year or college biology. This book contains 17 experiments including the 12 traditional AP* Biology labs. Additional advanced-level experiments make it appropriate for introductory college biology courses, as well. See page 32.

c. *Investigating Biology through Inquiry,* ORDER CODE **BIO-I**
Highly recommended for AP and IB† Biology.* This book, for data collection on computers and LabQuest only, will help you integrate inquiry into your high school or college biology curriculum. It provides many researchable questions for your students to investigate along with sample data for each investigation. See page 30.

d. *Human Physiology with Vernier,* ORDER CODE **HP-A**
This book, for data collection on computers and LabQuest only, contains 24 human physiology experiments. The experiments are designed to encourage students to think about the physiology of various human organ systems. See page 36.

e. *Water Quality with Vernier,* ORDER CODE **WQV**
This book contains 16 water quality tests, including pH, total dissolved solids, dissolved oxygen, BOD, flow rate, turbidity, nitrates, and phosphates. All nine tests in the Water Quality Index (WQI) are supported. See page 106.

f. *Investigating Environmental Science through Inquiry,* ORDER CODE **ESI**
Highly recommended for those teaching inquiry-based environmental science. This book contains 34 inquiry-based investigations. It covers issues that prompt students' interest in the effects of man-made environmental changes. Includes correlations for AP* and IB† environmental science. Student instructions are not platform specific. See page 68.

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†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Did you know? You can customize the lab instructions on your LabQuest using My LabQuest Library. See page 114 for details.

a. *Chemistry with Vernier,* ORDER CODE **CWV**
Highly recommended for first-year chemistry. This book contains 36 experiments in thermochemistry, gas laws, acid-base reactions, equilibrium, electrochemistry, electrolytes, states of matter, and more. See page 42.

b. *Advanced Chemistry with Vernier,* ORDER CODE **CHEM-A**
Highly recommended for second-year, AP, or college chemistry.* This book contains 35 advanced chemistry experiments. Many of the experiments align well with the 16 recommended AP chemistry experiments. See page 46.

c. *Investigating Chemistry through Inquiry,* ORDER CODE **CHEM-I**
Highly recommended for AP Chemistry.* This book contains 25 inquiry-based chemistry investigations in thermochemistry, acids and bases, stoichiometry, chemical kinetics, and properties of solutions. See page 44.

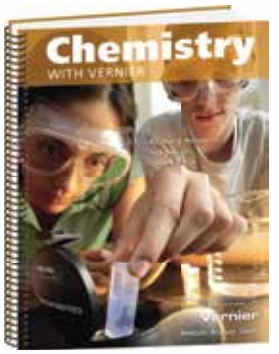
d. *Organic Chemistry with Vernier,* ORDER CODE **CHEM-O**
This book contains experiments designed for college organic chemistry courses. Experiments cover a broad range of topics, including compound identification, synthesis, chromatography, optical rotation, and spectroscopy. Experiments are written for computer and LabQuest only. See page 48.

e. UPDATED *Physics with Vernier,* ORDER CODE **PWV**
Highly recommended for first-year physics. This book contains 35 experiments in mechanics, sound, light, electricity, and magnetism. See page 84.

f. *Advanced Physics with Vernier – Mechanics,* ORDER CODE **PHYS-AM**
Highly recommended for AP Physics. This is the first of a two-volume set of experiments for the more in-depth introductory physics course, such as college physics, AP* Physics, or IB† Physics. Experiments are designed for an interactive teaching style and are written for computer and LabQuest only. See page 86.

g. *Advanced Physics with Vernier – Beyond Mechanics*
ORDER CODE **PHYS-ABM**
Highly recommended for advanced physics courses. This is the second of a two-volume set of new experiments for the more in-depth introductory physics course, such as college physics, AP* Physics, or IB† Physics. Experiments are designed for an interactive teaching style and are written for computer and LabQuest only.
See page 88.

h. *Physics with Video Analysis,* ORDER CODE **PVA**
This book contains a wide selection of video analysis activities using Logger *Pro* for introductory physics. Topics include kinematics, dynamics, circuits, sound, electrostatics, and more. Includes a CD with professionally made videos, student activities, solutions, and Logger *Pro* setup files. See page 102.



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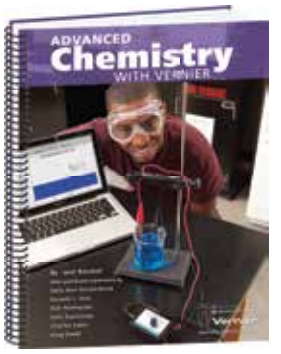

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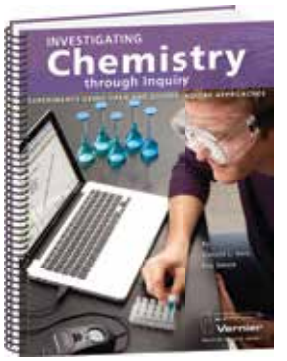

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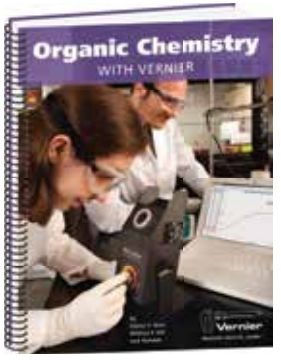

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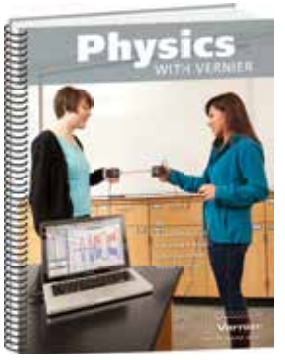

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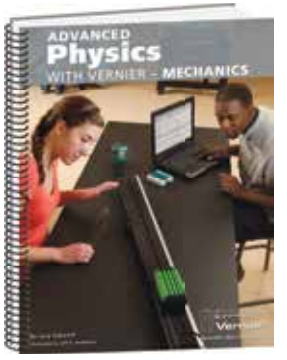

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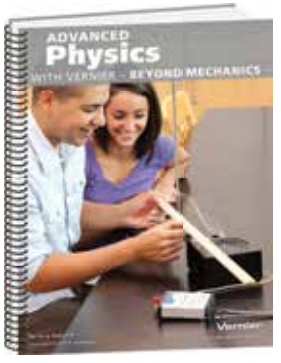

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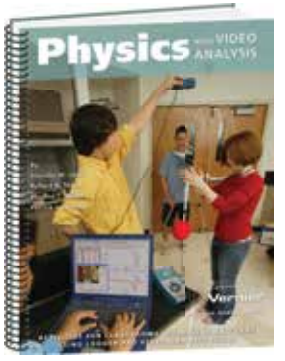

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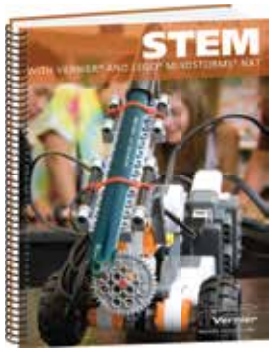

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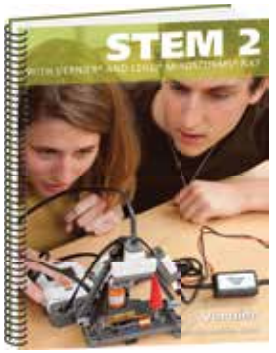

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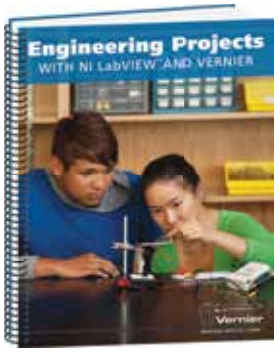

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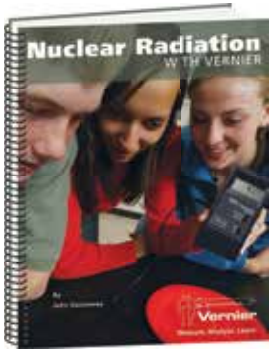


(f)

a. *STEM with Vernier and LEGO® MINDSTORMS® NXT,* ORDER CODE **STEM**

This book includes 14 environmental lab activities and 4 design-and-build robotics projects using pH, Conductivity, UV, and Soil Moisture Sensors coupled with the LEGO MINDSTORMS NXT intelligent interface. Includes a CD with MINDSTORMS NXT sample programs, movie clips, and LEGO Digital Designer files. See page 61.

b. *STEM 2 with Vernier and LEGO® MINDSTORMS® NXT*
ORDER CODE **STEM2**

This is our second book of projects and activities for engineering eduction and includes 12 lab activities and 8 design-and-build robotics projects. It covers topics in physical science and engineering, including mechanics, pressure, electricity, and magnetism. Includes a CD with MINDSTORMS NXT sample programs, movie clips, and LEGO Digital Designer files. See page 60.

c. *Engineering Projects with NI LabVIEW™ and Vernier,* ORDER CODE **EPV**

This book includes 12 engaging, hands-on projects that introduce engineering concepts and programming with NI LabVIEW software and SensorDAQ, LabQuest, LabQuest 2 or LabQuest Mini. Topics include analog and digital input and output, feedback and control, servo and stepper motors, PID control, and pulse-width modulation. See page 66.

d. *Hands-On Introduction to NI LabView™ with Vernier,* ORDER CODE **LWV**

This book introduces NI LabVIEW programming through a series of hands-on exercises using Vernier sensors and SensorDAQ, LabQuest, LabQuest 2 or LabQuest Mini. See page 67.

e. *Real-World Math with Vernier,* ORDER CODE **RWV**

This lab book contains 32 activities that explore real-world applications of math concepts from algebra through calculus. Activities cover topics such as linear, quadratic, and periodic functions, statistics, systems of equations, and many more. This book is for data collection on computers and calculators only. See page 120.

f. *Nuclear Radiation with Vernier,* ORDER CODE **NRV**

This book contains six experiments for data collection with a radiation monitor including Distance and Radiation, Counting Statistics, Lifetime Measurement, Background Radiation Sources, Radiation Shielding, and Alpha, Beta, and Gamma.

a. *Middle School Science with Vernier,* ORDER CODE **MSV**
This book is written specifically for students in grades 6–8. It contains 38 experiments in Earth science, life science, and physical science. See page 76.

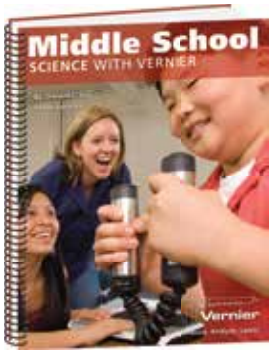
b. *Forensics with Vernier,* ORDER CODE **FWV**
This book is for teachers at the high school level who wish to introduce their students to forensics using engaging and realistic laboratory activities with Vernier probeware. The book contains 14 lab activities for computer and LabQuest only.

c. *Earth Science with Vernier,* ORDER CODE **ESV**
This book contains 33 experiments and 6 projects. Topics include geology, soil analysis, water quality, hydrology, oceanography, meteorology, and energy. See page 56.

d. *Physical Science with Vernier,* ORDER CODE **PSV**
This book contains 40 experiments for physical science (middle school through grade 10). These experiments are perfect for introductory physical science and integrated science classes. See page 80.

e. *Agricultural Science with Vernier,* ORDER CODE **AWV**
This lab book contains experiments specifically chosen for teaching topics in agricultural science at the high school or college level. Experiments range from the investigation of factors affecting transpiration, to the temperature effect shearing has on sheep, to the development of an understanding of Ohm's law.

f. *Elementary Science with Vernier,* ORDER CODE **EWV**
This book contains 43 fun and engaging experiments for elementary students. Activities investigate temperature, motion, force, magnetism, light, electricity, and pressure. This book is for data collection on computers and LabQuest only. See page 78.



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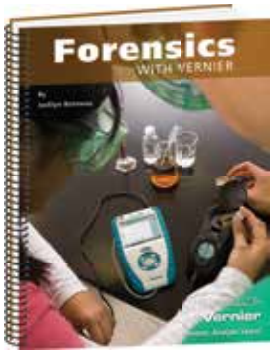

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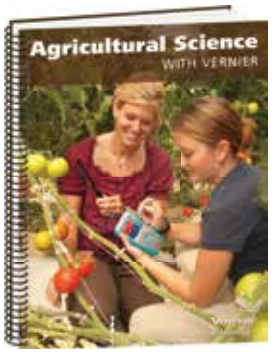

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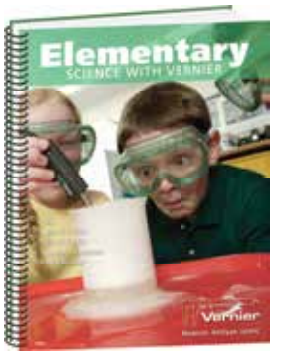

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VERNIER TEXTBOOK CORRELATIONS

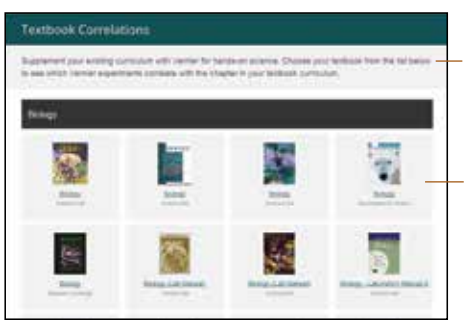
Vernier lab activities are matched to the tables of contents in dozens of popular textbooks. Check out the Vernier textbook correlations to see how easy it is for you to integrate technology into your curriculum.

MORE ONLINE – For more information, go to **www.vernier.com/textbook-correlations**

View specific textbook information

Easily identify correlated Vernier lab books

Detailed correlation report includes your textbook's chapter number and title, along with the correlated Vernier experiment title and sensor used.

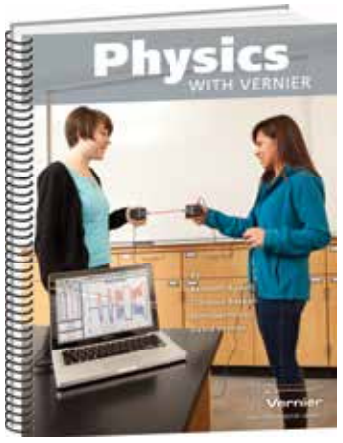


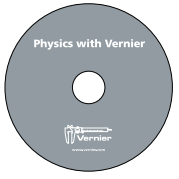
Many popular science textbooks have already been correlated.

Browse correlated textbooks by subject area or publisher name

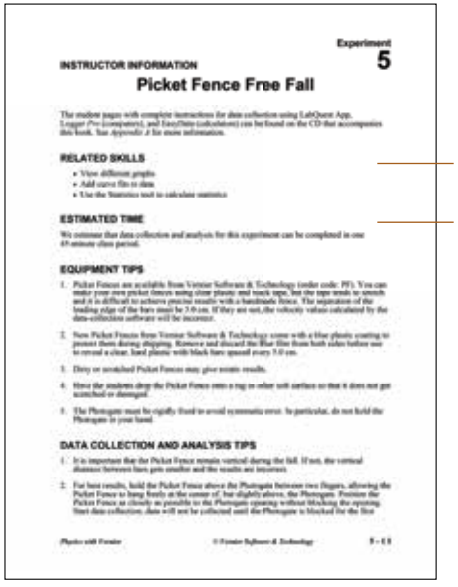
Lab Book Features

From *Physics with Vernier* lab book





CD includes easy-to-edit Word files *for the student experiments, and instructions for LabQuest, computers, and calculators, unless otherwise noted*


Experiment 5

INSTRUCTOR INFORMATION

Picket Fence Free Fall

RELATED SKILLS

ESTIMATED TIME

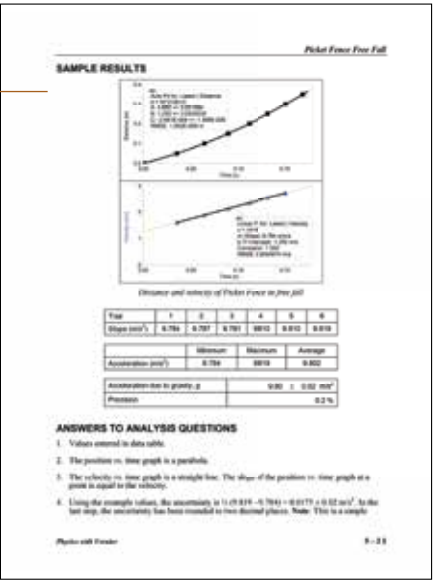
EQUIPMENT TIPS

DATA COLLECTION AND ANALYSIS TIPS

Sample data and graphs *let instructors see expected results*

Detailed teacher information *helps experiments run smoothly*

Time estimates *help with planning*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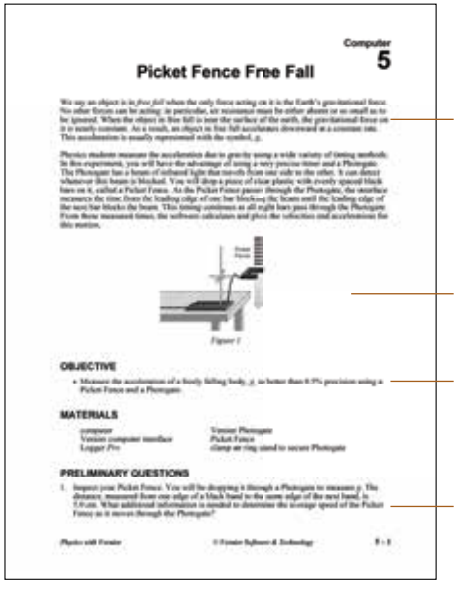
SAMPLE RESULTS

ANSWERS TO ANALYSIS QUESTIONS


Computer 5

Picket Fence Free Fall

OBJECTIVE

MATERIALS

PRELIMINARY QUESTIONS

Background information *reinforces the scientific concepts behind the experiment and helps enrich the laboratory experience*

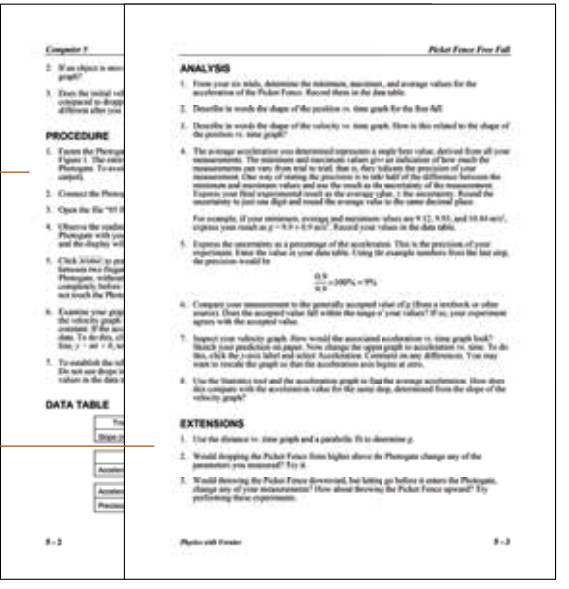
Procedures give ***detailed instructions***

Clear illustrations *help students visualize the experiment*

Concise objectives *specify desired student performance*

Extensions *provide suggestions for further investigation*

Preliminary questions *promote inquiry-based experiments*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PROCEDURE

DATA TABLE

ANALYSIS

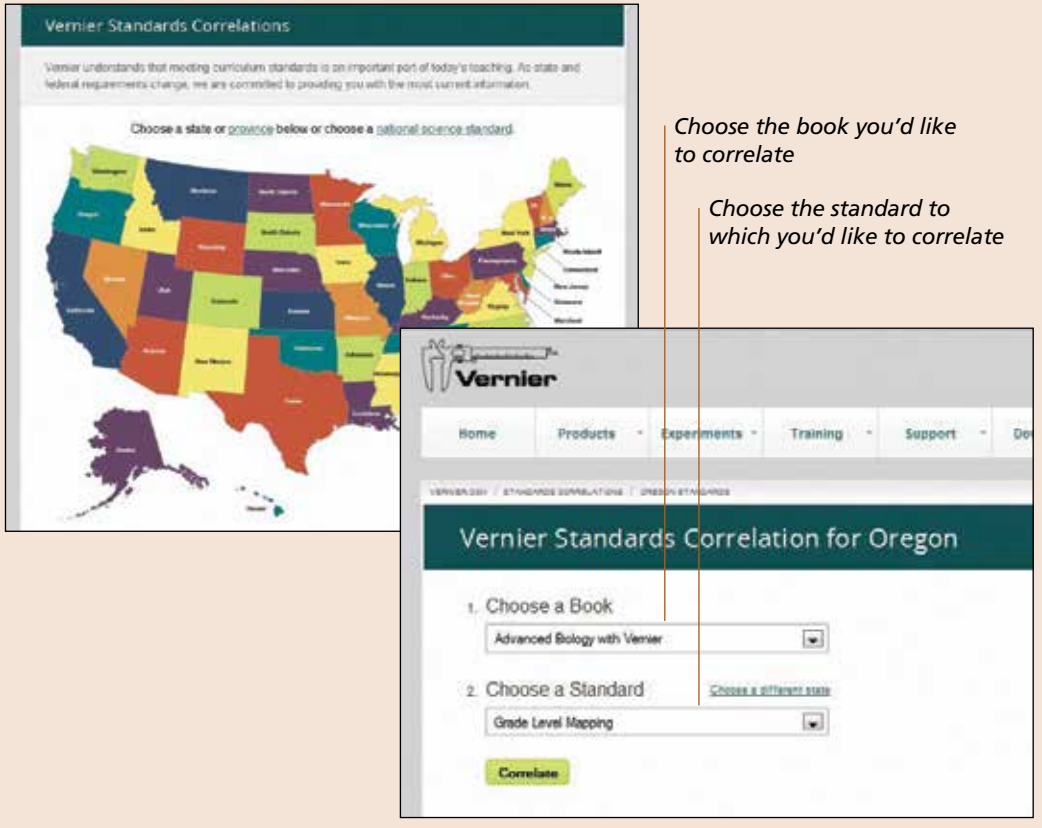
EXTENSIONS

Helping You Meet Content Standards

Vernier understands that meeting curriculum standards is an important part of today's teaching. As state and federal requirements change, we are committed to providing you with the most current information. You will find the following alignments to standards on our web site for all lab books published by Vernier at **www.vernier.com/standards**

- Science standards for all 50 U.S. states
- Provincial standards for Canada
- NCTM (National Council for Teachers of Mathematics)
- AP and IB
- NSES (National Science Education Standards)
- ISTE (International Society for Technology Educators)

VERNIER STANDARDS CORRELATION FOR YOUR STATE



MORE ONLINE – For more information, go to **www.vernier.com/standards**

VERNIER LAB BOOKS ARE A GREAT VALUE

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information
- Ready-to-use student versions of Logger *Pro* experiments in print; LabQuest, LabQuest Mini, computer, and calculator versions on CD, unless otherwise noted
- A generous site license—buy one book and duplicate labs for your class.
- Easily edit labs to meet your personal teaching style using Microsoft Word files for all versions of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/labs**

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Vernier has embedded over 100 of our most popular science experiments into LabQuest. My LabQuest Library allows you to create, customize, organize, and download labs to LabQuest for the entire class.

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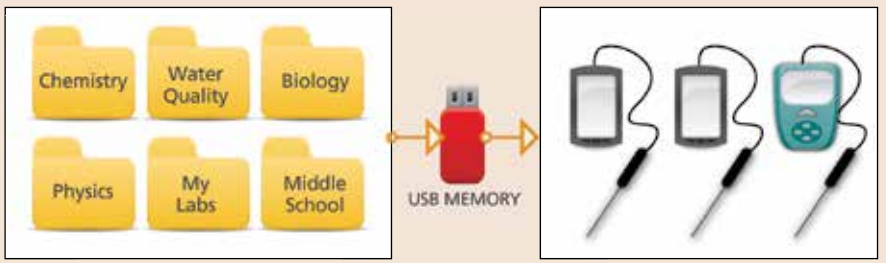
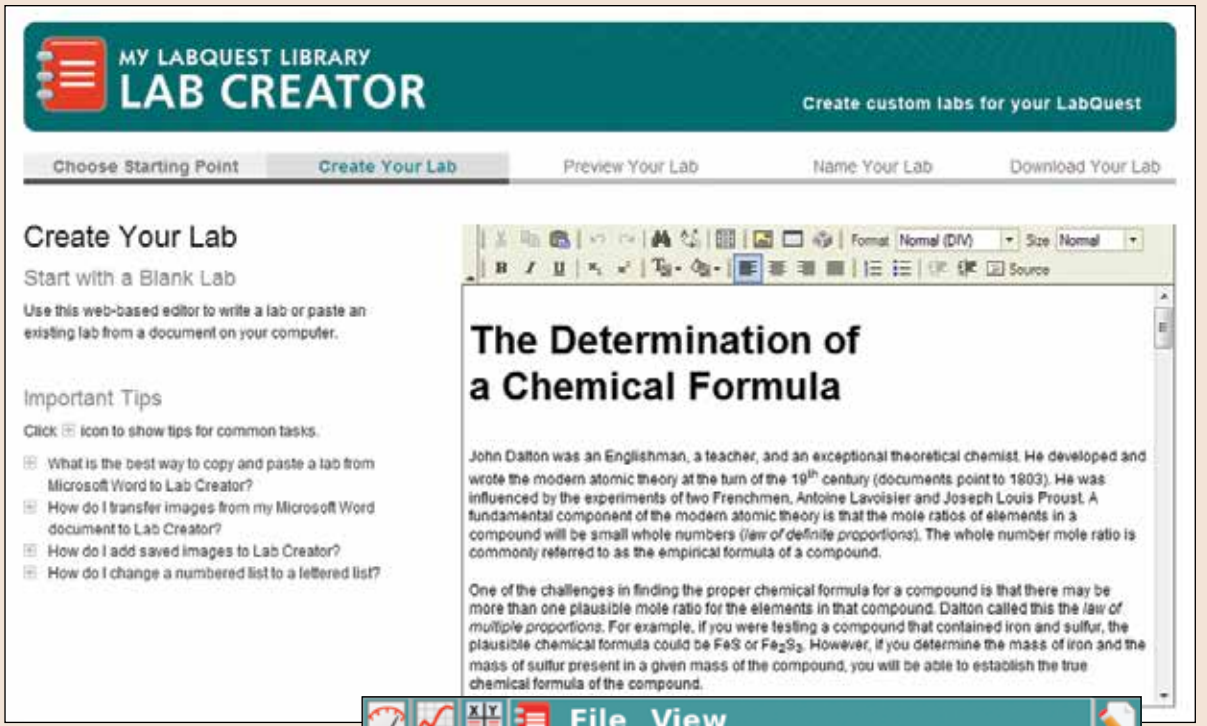
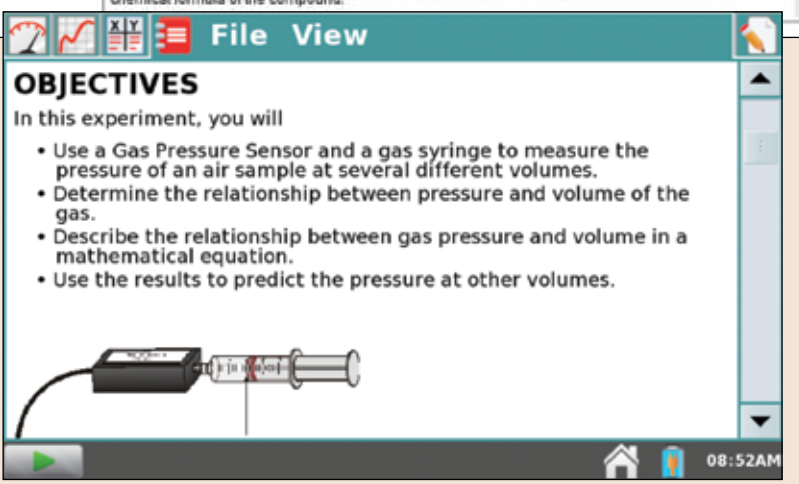
Customize your LabQuest with the Lab Organizer

In addition to our 100 most popular labs that are preloaded, more than 400 Vernier experiments from 16 lab books are available for you to upload to your LabQuest units!




MY LABQUEST LIBRARY
LAB CREATOR
Create custom labs for your LabQuest
Choose Starting Point
Create Your Lab
Preview Your Lab
Name Your Lab
Download Your Lab
Create Your Lab
Start with a Blank Lab
Use this web-based editor to write a lab or paste an existing lab from a document on your computer.
Important Tips
Click icon to show tips for common tasks.
What is the best way to copy and paste a lab from Microsoft Word to Lab Creator?
How do I transfer images from my Microsoft Word document to Lab Creator?
How do I add saved images to Lab Creator?
How do I change a numbered list to a lettered list?
The Determination of a Chemical Formula
John Dalton was an Englishman, a teacher, and an exceptional theoretical chemist. He developed and wrote the modern atomic theory at the turn of the 19th century (documents point to 1803). He was influenced by the experiments of two Frenchmen, Antoine Lavoisier and Joseph Louis Proust. A fundamental component of the modern atomic theory is that the mole ratios of elements in a compound will be small whole numbers (law of definite proportions). The whole number mole ratio is commonly referred to as the empirical formula of a compound.
One of the challenges in finding the proper chemical formula for a compound is that there may be more than one plausible mole ratio for the elements in that compound. Dalton called this the law of multiple proportions. For example, if you were testing a compound that contained iron and sulfur, the plausible chemical formula could be FeS or Fe2S3. However, if you determine the mass of iron and the mass of sulfur present in a given mass of the compound, you will be able to establish the true chemical formula of the compound.

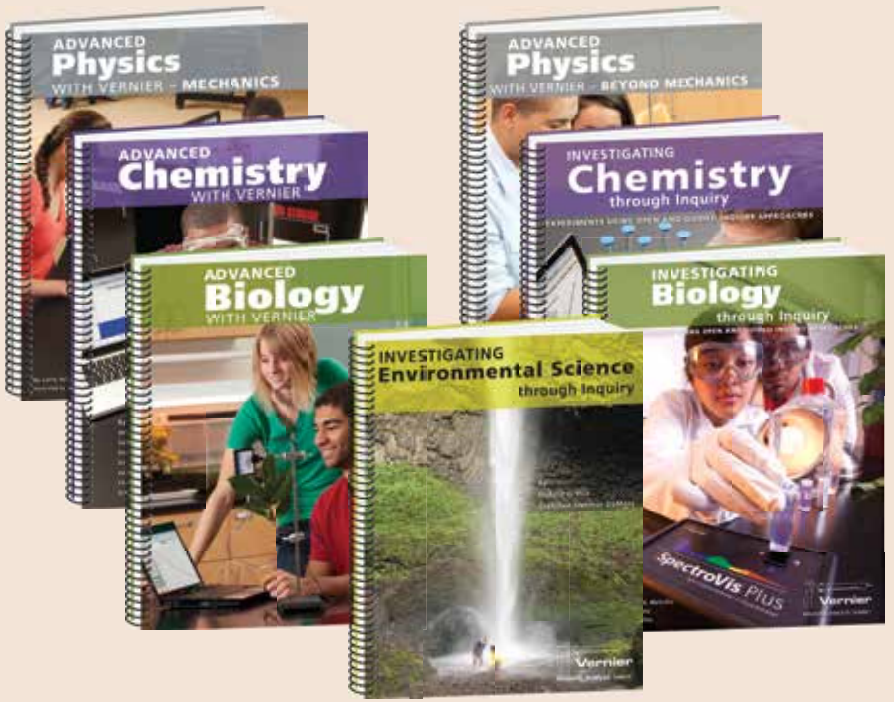
Create your custom lab with the Lab Creator.


File View
OBJECTIVES
In this experiment, you will
• Use a Gas Pressure Sensor and a gas syringe to measure the pressure of an air sample at several different volumes.
• Determine the relationship between pressure and volume of the gas.
• Describe the relationship between gas pressure and volume in a mathematical equation.
• Use the results to predict the pressure at other volumes.
08:52AM

Download it to your LabQuest.

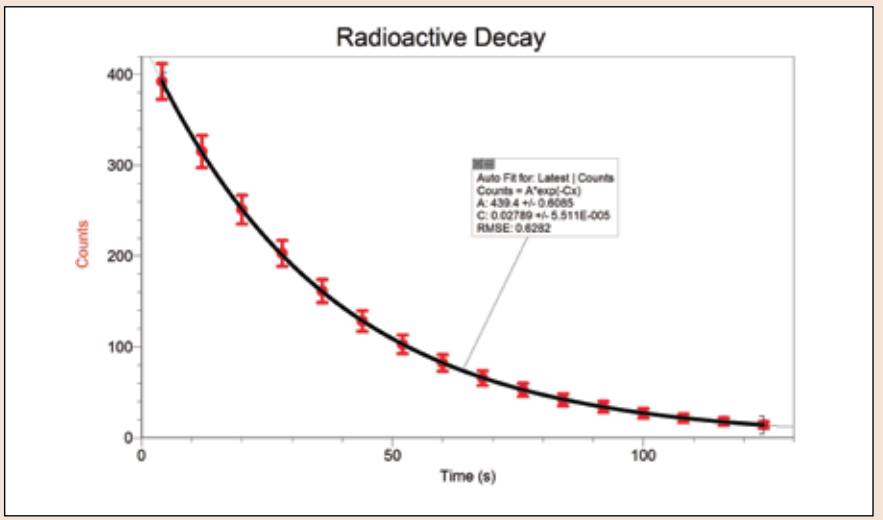
Your Complete Solution for AP* and IB† Science

CURRICULUM



- Correlations to AP and IB standards for biology, chemistry, physics, and environmental science
- Editable Word files for all student pages, so you can customize the labs to meet your standards
- ICT support for the IB Group 4 sciences
- Questions promote higher-order thinking skills
- Lab extensions encourage inquiry investigations

SOFTWARE



Logger *Pro* 3, ORDER CODE **LP,** One CD for Mac OS X and Windows

- Manual configuration mode allows students to set all data-collection parameters
- Error bars
- Log and semi-log graphs
- Modeling
- Custom curve fits
- Double y-graphs
- Gel analysis
- Peak integration on GC data
- Export data to Google Maps or GIS
- Spectrometer data analysis
- Video analysis

See pp. 22–25 for details.

IB Standards All IB Group 4 experimental science courses now require students to use sensors for data logging in an experiment and software for graph plotting. For IB correlations, visit **www.vernier.com/ib**

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†The IB Diploma Program is an official program of the International Baccalaureate Organization (IBO) which authorizes schools to offer it. The material available here has been developed independently of the IBO and is not endorsed by it.

Additional information on data-collection packages for AP and IB science can be found on the following pages:

Biology – page 31
Chemistry – page 45
Physics – pp. 87, 89
Environmental Science – page 69

TI-Nspire™ Technology for Math and Science

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TI-NSPIRE PRODUCTS

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Includes TI-Nspire CX handheld, rechargeable battery, and AC wall adapter.

TI-Nspire CX Teacher Bundle, ORDER CODE **TI-NSCX-TB**
Includes TI-Nspire CX handheld, rechargeable battery, AC adapter, and a single license of TI-Nspire Teacher Edition software.

TI-Nspire CX School Pack, ORDER CODE **TI-NSCX-TPK**
Includes 10 TI-Nspire CX EZ Spot handhelds with the words "School Property" on the keypad, 10 rechargeable batteries, and a 10-unit docking station.

TI-Nspire Computer Software – single-user license

TI-Nspire computer software and the TI-Nspire learning handheld share the same set of functionality, so you and your class can use either as a standalone learning tool.

Student Software, ORDER CODE **TI-NSSW-1**
Teacher Software, ORDER CODE **TI-N2T-SP-KT**
Teacher software includes license for both TI-Nspire and TI-Nspire CAS teacher software.

TI-NSPIRE CAS PRODUCTS

TI-Nspire CX CAS Handheld, ORDER CODE **TI-NSCXCAS**
Includes a TI-Nspire CX CAS handheld, rechargeable battery, AC wall adapter.

TI-Nspire CX CAS Teacher Bundle, ORDER CODE **TI-NSCXCAS-TB**
Includes TI-Nspire CX CAS handheld, rechargeable battery, AC adapter, and a single license of TI-Nspire CAS Teacher Edition software.

TI-Nspire CX CAS School Pack
ORDER CODE **TI-NSCXCAS-TPK**
Includes 10 TI-Nspire CAS handhelds, 10 rechargeable batteries, and a 10-unit docking station.

TI-Nspire CAS Computer Software – single user license
TI-Nspire CAS Computer Software is designed for algebra through calculus. It contains Computer Algebra System functionality.

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LAB: *Fast and efficient data collection with Vernier sensors*

FIELD: *Extend learning beyond the classroom*

Data Collection with TI-Nspire™ Technology

TI-Nspire™ Lab Cradle, ORDER CODE **TI-NSLABC**
The TI-Nspire Lab Cradle from Texas Instruments is a multi-channeled data-collection interface for use with TI-Nspire technology (sold separately). The Lab Cradle has five sensor ports for use with 70 Vernier sensors. Collect data up to 100,000 samples per second. The Lab Cradle is compatible with TI-Nspire computer software and handhelds running software version 3.0 or newer. The Lab Cradle includes a rechargeable battery and AC adapter.

TI-Nspire™ Lab Cradle Bundle, ORDER CODE **TI-NSLABC-5**
Includes 5 TI-Nspire Lab Cradles with rechargeable batteries, and a 5-unit charging bay.

ORDER CODE
TI-NSLABC

TI-LAB CRADLE COMPATIBLE SENSORS

SENSOR	CODE
Accelerometers	
3-Axis Accelerometer	3D-BTA
25-g Accelerometer	ACC-BTA
Low-g Accelerometer	LGA-BTA
Anemometer	ANM-BTA
Barometer	BAR-BTA
Blood Pressure Sensor	BPS-BTA
Charge Sensor	CRG-BTA
CO_2 Gas Sensor	CO2-BTA
Colorimeter	COL-BTA
Conductivity Probe	CON-BTA
Constant Current System	CCS-BTA
Current Probes	
Current Probe	DCP-BTA
High Current Sensor	HCS-BTA
Diffraction Apparatus	DAK
Dissolved Oxygen Probes	
Dissolved Oxygen Probe	DO-BTA
Optical DO Probe	ODO-BTA
IMPROVED Drop Counter	VDC-BTD
Dual-Range Force Sensor	DFS-BTA
EKG Sensor	EKG-BTA
Electrode Amplifier	EA-BTA
Ethanol Sensor	ETH-BTA
Flow Rate Sensor	FLO-BTA
Force Plate	FP-BTA

SENSOR	CODE
Gas Pressure Sensor	GPS-BTA
Goniometer	GNM-BTA
Hand Dynamometer	HD-BTA
Hand-Grip Heart Rate Monitor	HGH-BTA
Instrumentation Amplifier	INA-BTA
Ion-Selective Electrodes	
Ammonium Ion-Selective Electrode	NH4-BTA
Calcium Ion-Selective Electrode	CA-BTA
Chloride Ion-Selective Electrode	CL-BTA
Nitrate Ion-Selective Electrode	NO3-BTA
NEW Potassium Ion-Selective Electrode	K-BTA
Light Sensor	LS-BTA
Magnetic Field Sensor	MG-BTA
Melt Station	MLT-BTA
Microphone	MCA-BTA
Motion Detector	MD-BTD
NEW Motion Encoder System – *see pp. 96–97*	
O_2 Gas Sensor	O2-BTA
ORP Sensor	ORP-BTA
NEW PAR Sensor	PAR-BTA
pH Sensor	
pH Sensor	PH-BTA
pH Sensor, Tris-Compatible Flat	FPH-BTA
Photogate	VPG-BTD
Polarimeter (Chemical)	CHEM-POL
Projectile Launcher	VPL

SENSOR	CODE
Pyranometer	PYR-BTA
Radiation Monitors	
Vernier Radiation Monitor	VRM-BTD
Radiation Monitor (Digital)	DRM-BTD
Relative Humidity Sensor	RH-BTA
Respiration Monitor Belt (requires GPS-BTA)	RMB
Rotary Motion Sensor	RMV-BTD
Salinity Sensor	SAL-BTA
Soil Moisture Sensor	SMS-BTA
Sound Level Meter	SLM-BTA
Spirometer	SPR-BTA
Temperature Probes	
Extra-Long Temperature Probe	TPL-BTA
Infrared Thermometer	IRT-BTA
Stainless Steel Temperature Probe	TMP-BTA
Surface Temperature Sensor	STS-BTA
Thermocouple	TCA-BTA
Wide-Range Temperature Probe	WRT-BTA
Turbidity Sensor	TRB-BTA
UV Sensors	
UVA Sensor	UVA-BTA
UVB Sensor	UVB-BTA
Voltage Probes	
Differential Voltage Probe	DVP-BTA
Voltage Probe	VP-BTA
30-Volt Voltage Probe	30V-BTA

a

b

c

Save $$ with multi-user licenses of SmartView software. See **www.vernier.com/ti-smartview**

TI-84 Plus Graphing Calculators

TI graphing calculators are valuable tools in math and science. We recommend the TI-84 or the TI-Nspire (see page 116) family of calculators. These calculators can be purchased individually or in convenient teacher packs of 10 calculators.

a. TI-84 Plus C Silver Edition, ORDER CODE TI-84C

Introducing the next generation of the popular TI-84 Plus family of graphing calculators! The TI-84 C has a full-color, high-resolution, backlit screen, making it easy to read. The calculator comes with a rechargeable battery, so there is never a need to buy AAA batteries. Import real-world images as a graph background for analysis of features found in the image. Use with Vernier EasyData 4.0 for data collection with 66 Vernier sensors to investigate concepts in math and science. The TI-84 C has the same menu structure, navigation and applications, making the transition from a TI-83/84 seamless.

Features include
- High-resolution, backlit, full-color display
- Built-in rechargeable battery
- Familiar TI-84 Plus functionality
- Import digital images (jpg, jpeg, bmp, and png)
- MathPrint™ option to see expressions as they appear in textbooks

Also available in a Teacher Pack of 10 handhelds that includes 10 EZ-Spot calculators and a 10-unit charging station.

TI-84 Plus C Teacher Pack, ORDER CODE TI-84C-TPK

b. TI-84 Plus, ORDER CODE TI-84PL

- A lower price alternative to the TI-84 Plus C Silver Edition calculator
- Over ten preloaded Apps including EasyData and Cabri™ Jr.

TI-84 EZ Spot Teacher Pack, ORDER CODE TI-84SPOTTP

c. TI-SmartView™ Emulator Software

ORDER CODE TI-SV *(Single-user license)*

TI-SmartView lets you project an interactive representation of a TI-84 Plus calculator to your entire class. You can use TI-SmartView to project multiple representations simultaneously (graphs, window settings, tables), display key press history, and capture multiple screenshots. TI-SmartView is ideal for use with interactive whiteboards. For multi-user licenses of SmartView software, go to **www.vernier.com/ti-smartview**

EASYDATA 2.4 / 4.0

We have updated the EasyData App for the TI-83/84 Plus family of graphing calculators.

EasyData 2.4 supports
- TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, and TI-84 Plus Silver Edition

EasyData 4.0 supports
- TI-84 Plus C Silver Edition (comes preloaded on calculator)

EasyData 2.4 and 4.0 new features include
- Support for additional sensors
  - 30-Volt Voltage Probe
  - Wide-Range Temperature Probe
  - Vernier Melt Station
  - Ethanol Sensor
  - Vernier Optical DO Probe
- Manual scaling of graph from within the App
- Manual setup of Live Graph Scaling
  - includes option to turn off Auto Scale

EasyData 4.0 only features include
- Support for the TI-84 C high-resolution, color screen
- Sensor meters and graphs use color to identify different data columns

FREE download at **www.vernier.com/easydata**

Exponential cooling curve

INTERFACES

We offer several interface options for data collection for different budgets and classroom setups. For a detailed comparison of your interface options, see **www.vernier.com/calculator-interfaces**

Vernier LabPro

ORDER CODE
LABPRO

The Vernier LabPro Interface is our full-featured, data-collection interface offering everything that you need for data collection with a TI graphing calculator. LabPro can also be connected to a computer for additional data-collection options.

For more information go to **www.vernier.com/labpro**

Texas Instruments CBL 2

ORDER CODE
CBL2

The CBL 2 is an easy-to-use, powerful, and inexpensive data-collection tool. The CBL 2 System includes the CBL 2 interface, a Stainless Steel Temperature Probe, TI Light Probe, Voltage Probe, calculator cradle, link cable, batteries, user's guide, and a TI resource CD.

Over 65 Vernier sensors can be connected to the CBL 2. For CBL 2 sensor packages go to **www.vernier.com/pkgs**

Vernier EasyLink™

ORDER CODE
EZ-LINK

With the Vernier EasyLink, data collection with a TI graphing calculator is easier and more affordable.

EasyLink is a single-channel interface that plugs into the USB port of a TI-84 graphing calculator or TI-Nspire Handheld. It supports any one of **over 50 Vernier sensors**.

EasyLink is an affordable way to get started with calculator-based data collection!

Direct-Connect USB Sensors

Direct-connect USB sensors can be used with supported TI calculators without an interface. All other Vernier sensors require a sensor interface.

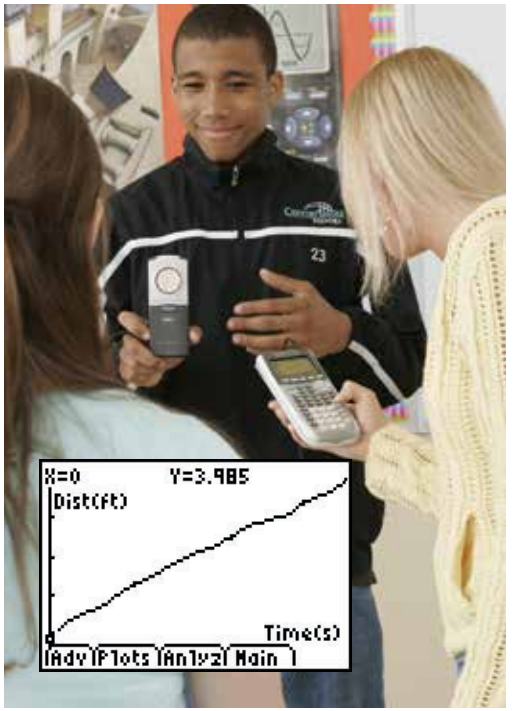
a. Vernier EasyTemp, ORDER CODE EZ-TMP

The Vernier EasyTemp is inexpensive and easy to use! What more can you ask for? Plug Vernier EasyTemp into the USB port on a TI-84 Plus calculator or TI-Nspire handheld*. The data-collection application automatically launches, and you are ready to collect data! This stainless-steel probe is durable for classroom use and covers a temperature range of –20°C to 115°C.

* EasyTemp can only be used with TI-84 and TI-Nspire handhelds.

b. CBR 2, ORDER CODE CBR2

If you teach math, physical science, or physics, consider the CBR 2. The CBR 2 collects distance, velocity, and acceleration data. It connects directly to a TI calculator. When the CBR 2 is connected to the USB port of a TI-84 Plus calculator or TI-Npsire handheld, the data-collection application automatically launches, and you are ready to collect data.



Graphing constant motion

1 IT ALL STARTS WITH CURRICULUM

Aligned to state and national math and science standards, this book contains experiments for TI-Nspire technology, TI graphing calculators, and computers.

2 CHOOSE YOUR INTERFACE

For TI-Nspire Technology (handhelds and computer software):

Lab Cradle - For use with TI-Nspire handhelds and computer software. See page 117.

EasyLink - Single-channel sensor interface. See page 119.

For TI Calculators (TI-83/84 Plus, TI-73 Explorer, TI-89 Titanium):

LabPro - Use with TI calculators or computers running our Logger *Pro* software. (Not for use with TI-Nspire) See page 122.

CBL 2 - Use with TI calculators only. (Not for use with TI-Nspire) See page 119.

EasyLink - TI-84 Plus only (see above)

For computers running Vernier Logger Pro *software:*

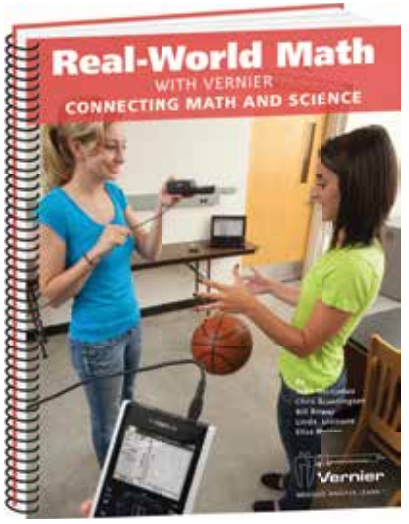
LabPro - see above

LabQuest Mini - Use with computers running Logger *Pro* software. See pp. 18–19.

3 CHOOSE OR BUILD YOUR PACKAGE OF SENSORS

Choose from Vernier's recommended packages or build your own.

Build custom packages online at www.vernier.com/guide



MATH ACTIVITY BOOK

ORDER CODE **RWV** Supports TI-Nspire, TI-84 Plus, TI-73, TI-89, and more!

Vernier lab books are loaded with teacher tips, sample graphs, and more. When you buy the lab book, you will receive

- Essential teacher information
- 32 ready-to-use student versions of TI-Nspire activities in print
- A generous site license—buy one book and duplicate labs for your class
- Easily edit labs to meet your personal teaching style using Microsoft® Word® files for all of the experiments on CD
- Suggested answers, sample data, and graphs
- Complete equipment and supplies list

The downloadable evaluation PDFs include student instructions only.

DOWNLOAD evaluation PDFs for all student experiments at **www.vernier.com/rwv**

Real-World Math with Vernier: Connecting Math and Science activity book contains the following activities:

☐ **USING A MOTION DETECTOR**
- Straight Line Distance Graphs
- Newton's Second Law*†
- The Linear Force Relation for a Rubber Band*†
- Position and Time for a Cart on a Ramp
- Height and Time for a Bouncing Ball
- Definition of Rate
- Interpreting Velocity Graphs
- Applications of the Distance Formula
- Exponential Pattern of Rebound Heights
- Pendulum Motion
- Damped Harmonic Motion
- Describing Data With Statistical Plots
- Solving a System of Linear Equations
- Plotting an Ellipse
- Parametric Plots
- Piecewise-Defined Functions
- Greatest Integer Functions
- Period and Length of a Simple Pendulum

☐ **USING A LIGHT SENSOR**
- Distance and Intensity
- Periodic Phenomena*

☐ **USING A TEMPERATURE PROBE**
- Mixing Liquids of Different Temperatures
- How Hot Objects Cool
- Describing Data with Statistics*

☐ **USING A VOLTAGE PROBE**
- Exponential Models

☐ **USING A GAS PRESSURE SENSOR**
- Linear Relationship between Water Depth and Pressure
- Linear Rates of Pressure Increase
- The Inverse Relationship between Pressure and Volume

☐ **USING A MICROPHONE**
- Sound Waveform Models*

☐ **USING A FORCE SENSOR**
- Linear Relationship between Weight and Quantity
- Volume and Weight
- Newton's Second Law*
- The Linear Force Relation for a Rubber Band*

☐ **USING A pH SENSOR**
- The Exponential pH Change
- An Application of the Logistic Function

☐ STARTER PACKAGES ☐ DELUXE PACKAGES

* Experiment not supported by Easy Package † Requires Deluxe Package

Logger *Pro* 3

ORDER CODE **LP**

This award-winning software is the best value around! Includes a site license for all computers in your school or your college department. Use Logger *Pro* with the activities in the *Real-World Math with Vernier* book. You can also import data from TI calculators for further analysis on a computer. (This feature not supported with TI-Nspire handhelds.)

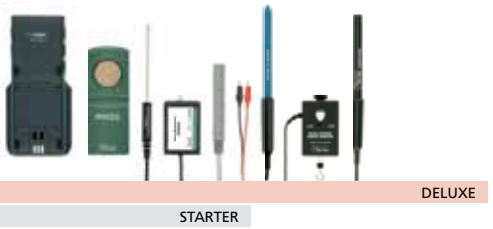
Math TI-Nspire Lab Cradle and EasyLink Packages

Purchase one package per group (2–4 students) OR BUILD YOUR OWN PACKAGE from the list of recommended sensors below.

TI-Nspire Lab Cradle

TI-Nspire Technology (Handhelds or Computer Software)

TI-NSPIRE LAB CRADLE INTERFACE & SENSORS	CODE	Starter Package LC-MATH-ST	Deluxe Package LC-MATH-DX
TI-Nspire Lab Cradle Interface	**TI-NSLABC**	✔	✔
Motion Detector	MD-BTD	✔	✔
Stainless Steel Temperature Probe	TMP-BTA	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
TI Light Probe	TILT-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
pH Sensor	PH-BTA		✔
Dual-Range Force Sensor	DFS-BTA		✔
Microphone	MCA-BTA		✔
Save when you purchase sets of 5 (Includes Lab Cradle Bundle – see page 117)		**LC-MATH-ST5**	**LC-MATH-DX5**



YOU WILL ALSO NEED:

Real-World Math with Vernier activity book ORDER CODE **RWV.** See previous page.

TI-Nspire Handheld or computer software. See page 116.

For a complete list of compatible sensors, go to page 117 or **www.vernier.com/ti-nslabc**

EasyLink

TI-Nspire Handhelds or TI-84 Plus calculators only

EASYLINK INTERFACE & SENSORS	CODE	Starter Package MATH-EZ-STR	Deluxe Package MATH-EZ-DX
Vernier EasyLink Interface	**EZ-LINK**	✔	✔
CBR 2 – Motion Detector	CBR2	✔	✔
EasyTemp Temperature Probe	EZ-TMP	✔	✔
Gas Pressure Sensor	GPS-BTA	✔	✔
TI Light Probe	TILT-BTA	✔	✔
Voltage Probe	VP-BTA	✔	✔
pH Sensor	PH-BTA		✔
Dual-Range Force Sensor	DFS-BTA		✔
EASYLINK	MATH PACKAGE		

YOU WILL ALSO NEED:

Real-World Math with Vernier activity book ORDER CODE **RWV.** See previous page.

TI-Nspire Handheld see page 116, or **TI-84 Plus Calculator** see page 118.

For a complete list of compatible sensors, go to pp. 124–125 or **www.vernier.com/easylink**

MORE ONLINE

For additional math package options visit **www.vernier.com/products/packages/math**

TI-NSPIRE HANDHELDS AND SOFTWARE

Looking for TI-Nspire graphing handhelds and software? See page 116 or visit **www.vernier.com/ti-nspire**

TI-84 PLUS CALCULATORS

Looking for TI-84 Plus Graphing calculators? See page 118 for more details.

Versatile Solution for Calculator and Computer Data Collection

ORDER CODE
LABPRO

Three different ways to collect data! You can use LabPro with a computer, Texas Instruments graphing calculator, or on its own as a remote data collector.

- Multi-channel interface
- Over 70 Vernier sensors are compatible with the LabPro
- Six data-collection channels allow you to use multiple sensors at once
- Samples up to 50,000 readings per second

Included with LabPro: LabPro unit, power adapter, USB computer cable, calculator cable, calculator cradle, DataMate calculator program, user manual, voltage probe

LABPRO COMPATIBLE SENSORS

SENSOR	CODE
Accelerometers	
3-Axis Accelerometer	3D-BTA
25-g Accelerometer	ACC-BTA
Low-g Accelerometer	LGA-BTA
Anemometer	ANM-BTA
Barometer	BAR-BTA
Blood Pressure Sensor *	BPS-BTA
Charge Sensor	CRG-BTA
CO_2 Gas Sensor	CO2-BTA
Colorimeter	COL-BTA
Conductivity Probe	CON-BTA
Constant Current System	CCS-BTA
Current Probes	
Current Probe	DCP-BTA
High Current Sensor	HCS-BTA
Diffraction Apparatus *	DAK
IMPROVED Digital Control Unit †	DCU-BTD
Dissolved Oxygen Probes	
Dissolved Oxygen Probe	DO-BTA
Optical DO Probe	ODO-BTA
IMPROVED Drop Counter †	VDC-BTD
Dual-Range Force Sensor	DFS-BTA
EKG Sensor	EKG-BTA
Electrode Amplifier	EA-BTA
Ethanol Sensor †•	ETH-BTA
Flow Rate Sensor	FLO-BTA
Force Plate	FP-BTA

SENSOR	CODE
Gas Pressure Sensor	GPS-BTA
Goniometer	GNM-BTA
Hand Dynamometer	HD-BTA
Hand-Grip Heart Rate Monitor	HGH-BTA
Instrumentation Amplifier	INA-BTA
Ion-Selective Electrodes	
Ammonium Ion-Selective Electrode	NH4-BTA
Calcium Ion-Selective Electrode	CA-BTA
Chloride Ion-Selective Electrode	CL-BTA
Nitrate Ion-Selective Electrode	NO3-BTA
NEW Potassium Ion-Selective Electrode	K-BTA
Light Sensor	LS-BTA
Magnetic Field Sensor	MG-BTA
Melt Station †•	MLT-BTA
Microphone	MCA-BTA
Motion Detector	MD-BTD
NEW Motion Encoder System *† – *see pp. 96–97*	
O_2 Gas Sensor	O2-BTA
ORP Sensor	ORP-BTA
NEW PAR Sensor	PAR-BTA
pH Sensors	
pH Sensor	PH-BTA
Tris-Compatible Flat pH Sensor	FPH-BTA
Photogate †	VPG-BTD
Polarimeter (Chemical) *†	CHEM-POL
Power Amplifier	PAMP
Projectile Launcher †	VPL

SENSOR	CODE
Pyranometer	PYR-BTA
Radiation Monitors	
Radiation Monitor † (Digital)	DRM-BTD
Vernier Radiation Monitor †	VRM-BTD
Relative Humidity Sensor	RH-BTA
Respiration Monitor Belt *(requires GPS-BTA)*	RMB
Rotary Motion Sensor †	RMV-BTD
Salinity Sensor	SAL-BTA
Soil Moisture Sensor	SMS-BTA
Sound Level Meter	SLM-BTA
Spirometer	SPR-BTA
Temperature Probes	
Extra-Long Temperature Probe	TPL-BTA
Infrared Thermometer	IRT-BTA
Stainless Steel Temperature Probe	TMP-BTA
Surface Temperature Sensor	STS-BTA
Thermocouple	TCA-BTA
Wide-Range Temperature Probe •	WRT-BTA
Turbidity Sensor	TRB-BTA
UV Sensors	
UVA Sensor	UVA-BTA
UVB Sensor	UVB-BTA
Voltage Probes	
Differential Voltage Probe	DVP-BTA
Voltage Probe	VP-BTA
30-Volt Voltage Probe •	30V-BTA

* Use with computers only † Not supported with Logger Lite software • Calculators require EasyData v2.4 or higher.

CALCULATOR PRODUCTS PRICE LIST

PRODUCT	CODE
Calculators – TI-84 Plus	
TI-84 Plus Calculator	TI-84PL
TI-84 Plus EZ Spot Teacher Pack	TI-84SPOTTP
TI-84 Plus C Silver Edition Calculator	TI-84C
TI-84 Plus C Teacher Pack *(includes 10-unit Charging Station)*	TI-84C-TPK
Calculators – TI-Nspire	
TI-Nspire CX Handheld	TI-NSCX
TI-Nspire CX Teacher Bundle *(handheld & TE software)*	TI-NSCX-TB
TI-Nspire CX School Pack *(10 handhelds & docking station)*	TI-NSCX-TPK
TI-Nspire CX CAS Handheld	TI-NSCXCAS
TI-Nspire CX CAS Teacher Bundle *(handheld & TE software)*	TI-NSCXCAS-TB
TI-Nspire CX CAS School Pack *(10 handhelds & docking station)*	TI-NSCXCAS-TPK
Charging/Docking Stations	
TI-84 Plus C Charging Station	TI-84C-CS
TI-Nspire CX Docking Station	TI-NSCX-DS
Direct Connect USB Sensors	
EasyTemp	EZ-TMP
Calculator-Based Ranger 2	CBR2
Emulator/Computer Software	
TI SmartView Emulator software for TI-84 *(single-user license)*•	TI-SV
TI-Nspire Student Computer Software *(single license)*•	TI-NSSW-1
TI-Nspire CAS Student Computer Software *(single license)*•	TI-NSCASSW-1
TI-Nspire Teacher Software *(single license numeric & CAS software)*	TI-N2T-SP-KT
Miscellaneous Accessories	
AC Adapter *(for LabPro, CBL 2, CBL)*	IPS
Calculator-to-Calculator Link Cable	TI-CLC
Short Calculator Link Cable	TI-SLC
TI Kickstand Slide Cover	TI-KSC
TI USB Connectivity Kit	GLC-USB
Real-World Math with Vernier lab book	RWV
Sensor Interfaces	
CBL 2 System	CBL2
Vernier LabPro	LABPRO
Vernier EasyLink	EZ-LINK
TI-Nspire Lab Cradle	TI-NSLABC
TI-Nspire Lab Cradle Bundle *(includes 5-unit Charging Bay)*	TI-NSLABC-5
TI Navigator Systems	
32-User Standard TI-Navigator System	TI-NAV-SD
16-User Starter TI-Navigator System	TI-NAV-STR
4-User TI-Navigator Add-on†	TI-NAV-IND
30-User TI-Nspire CX Navigator System°	TI-NAV-CX30
15-User TI-Nspire CX Navigator System°	TI-NAV-CX15
5-User TI-Nspire CX Navigator Add-on†°	TI-NAV-CX5
TI-Nspire Navigator Teacher Software Add-on†	TI-NAV-CXSW
TI-Nspire Navigator for Network Computers	TI-NAVNNC-SP-KT

† Requires purchase of a Navigator system.
• Lower-price, multi-user license software also available. See **www.vernier.com/ti-nspire-licenses**
° Use with CX handhelds only, sold separately.

TI products purchased in the USA are covered by a one-year warranty based on the date of purchase. Units are warranted against defective materials or workmanship.

TI-NAVIGATOR™ CLASSROOM LEARNING SYSTEMS

The TI-Navigator is a classroom learning system that combines Texas Instruments graphing technology and your classroom PC to create a wireless classroom network. Teachers can assess understanding of key concepts, monitor student progress, and differentiate instruction. The included software supports automatically grading and archiving student work. Learn more at **www.vernier.com/ti-navigator**

a. For TI-83/84* or TI-73 Users

32-User Standard TI-Navigator System
ORDER CODE **TI-NAV-SD**

16-User Starter TI-Navigator System
ORDER CODE **TI-NAV-STR**

4-User TI-Navigator System Add-on†
ORDER CODE **TI-NAV-IND**

* Cannot be used with TI-84 Plus C Silver Edition calculators
† Add-on pieces require the purchase of a Standard or Starter TI-Navigator System.

b. For TI-Nspire™ CX or TI-Nspire CX CAS Users**

30-User TI-Nspire CX Navigator System,
ORDER CODE **TI-NAV-CX30**

15-User TI-Nspire CX Navigator System
ORDER CODE **TI-NAV-CX15**

5-User TI-Nspire CX Navigator Add-On‡
ORDER CODE **TI-NAV-CX5**

TI-Nspire Navigator Teacher Software Add-On,‡
ORDER CODE **TI-NAV-CXSW**

** This system is for use with TI-Nspire CX handhelds only and will not work with older clickpad or touchpad units.
‡ Add-on pieces require the purchase of a 30-User or 15-User TI-Nspire Navigator system.

c. TI-Nspire Navigator for Networked Computers

ORDER CODE **TI-NAVNNC-SP-KT**

Use with TI-Nspire / TI-Nspire CAS student software (not included).

a

b

c

The Vernier Sensor Advantage

OUTSTANDING PERFORMANCE

Vernier sensors are designed specifically for education and held to high standards for quality and durability. With 33 years of experience developing technology for education, we design our sensors for active, hands-on experiments. Vernier sensors are rugged, classroom-proven technology that are well supported and easy to use. The sensors provide consistent, high-quality results for the demands of the classroom.

CONNECT & COLLECT

Just connect and you're ready to collect. All Vernier sensors on the following pages are automatically detected and set up for data collection when used with Vernier software. It's student-friendly technology designed for ease of use.

GENEROUS WARRANTY

Buy with confidence. Most Vernier sensors are covered by a 5-year warranty. In Vernier's 33 years of business, we have rarely charged a customer for a repair, no matter how old the equipment.

INTERFACE-CONNECT SENSORS

Interface-connect sensors require additional hardware, called an interface. An interface includes a powerful data-acquisition processor to send sensor data to data-collection and analysis software. Most of our sensors are interface-connect so they will work on a variety of platforms, such as computers, tablets, or TI graphing calculators.

MORE INFORMATION ON SENSOR COMPATIBILITY	
INTERFACE	**MORE INFORMATION**
LabQuest 2 (Standalone, computers, tablets)	Page 16
LabQuest Mini (Computers)	Page 19
Go!Link (Computers)	Page 20
LabPro (TI Calculators or computers)	Page 122
TI-Lab Cradle (TI-Nspire technology)	Page 117
EasyLink (TI Calculators or TI-Nspire technology)	www.vernier.com/ez-link

USB SENSORS

USB Sensors connect directly to a computer or LabQuest 2, or, in some instances (CBR 2 and EasyTemp), with TI handhelds and calculators. No sensor interface is required. For more information on USB sensors see **www.vernier.com/usb-sensors**

WIRELESS SENSORS

Wireless sensors communicate directly with host devices (iPad, LabQuest 2, for example, and, in some instances, computers) via Bluetooth communication. No sensor interface is required. For more information on wireless sensors see **www.vernier.com/wireless-sensors**

OVER 80 SENSORS AVAILABLE					
SENSOR	**CODE**	**LABQUEST 2/ MINI**	**GO!LINK/ EASYLINK**	**USB OR WIRELESS**	**PAGE**
Accelerometers					
3-Axis Accelerometer	3D-BTA	✔			126
25-g Accelerometer	ACC-BTA	✔	✔		126
Low-g Accelerometer	LGA-BTA	✔	✔		126
Anemometer	ANM-BTA	✔	✔		126
Barometer	BAR-BTA	✔	✔		126
Blood Pressure Sensor	BPS-BTA	✔	✔[1]		127
Charge Sensor	CRG-BTA	✔	✔		127
CO_2 Gas Sensor	CO2-BTA	✔	✔		127
Colorimeter	COL-BTA	✔	✔		128
Conductivity Probe	CON-BTA	✔	✔		128
Constant Current System	CCS-BTA	✔	✔		128
Current Probes					
Current Probe	DCP-BTA	✔	✔		129
High Current Sensor	HCS-BTA	✔	✔		129
Diffraction Apparatus	DAK	✔			100
IMPROVED Digital Control Unit	DCU-BTD	✔[2]			129
Dissolved Oxygen Probes					
Dissolved Oxygen Probe	DO-BTA	✔	✔		130
Vernier Optical DO Probe	ODO-BTA	✔			130
IMPROVED Drop Counter	VDC-BTD	✔			130
Dual-Range Force Sensor	DFS-BTA	✔	✔		130
EKG Sensor	EKG-BTA	✔	✔		131
Electrode Amplifier	EA-BTA	✔	✔		131
Ethanol Sensor	ETH-BTA	✔			131
Flow Rate Sensor	FLO-BTA	✔	✔		132
Force Plate	FP-BTA	✔	✔		132
Gas Pressure Sensor	GPS-BTA	✔	✔		132
Goniometer	GNM-BTA	✔	✔		133
Hand Dynamometer	HD-BTA	✔	✔		133
Hand-Grip Heart Rate Monitor	HGH-BTA	✔	✔		133
Instrumentation Amplifier	INA-BTA	✔	✔		134
Ion-Selective Electrodes					
Ammonium Ion-Selective Electrode	NH4-BTA	✔	✔		134
Calcium Ion-Selective Electrode	CA-BTA	✔	✔		134
Chloride Ion-Selective Electrode	CL-BTA	✔	✔		134
Nitrate Ion-Selective Electrode	NO3-BTA	✔	✔		134
NEW Potassium Ion-Selective Electrode	K-BTA	✔	✔		134
Light Sensor	LS-BTA	✔	✔		134
Magnetic Field Sensor	MG-BTA	✔	✔		135
Mass (Ohaus Balances)					54
Scout Pro 0.01 g (200 g)	OHSP-202	✔		*USB*	54
Scout Pro 0.01 g (400 g)	OHSP-402	✔		*USB*	54
Scout Pro 0.001 g (120 g)	OHSP-123	✔		*USB*	54

SENSOR	CODE	LABQUEST 2/ MINI	GO!LINK/ EASYLINK	USB OR WIRELESS	PAGE
Melt Station	MLT-BTA	✔	✔		135
Microphone	MCA-BTA	✔			135
Mini GC Plus	GC2-MINI	✔		*USB*	136
Motion Detectors					
Motion Detector	MD-BTD	✔			136
Go!Motion	GO-MOT	✔		*USB*	136
CBR 2 *(calculators only)*	CBR2			*USB*[3]	119
NEW Motion Encoder System – *see pp. 96–97*		✔			
NODE Wireless Sensors				*Wireless*	7
O_2 Gas Sensor	O2-BTA	✔	✔		137
ORP Sensor	ORP-BTA	✔	✔		137
NEW PAR Sensor	PAR-BTA	✔	✔		137
pH Sensors					
pH Sensor	PH-BTA	✔	✔		138
pH Sensor, Tris-Compatible Flat	FPH-BTA	✔	✔		138
Photogate	VPG-BTD	✔			138
Polarimeter (Chemical)	CHEM-POL	✔			139
Power Amplifier	PAMP	✔			139
Projectile Launcher	VPL	✔			101
Pyranometer	PYR-BTA	✔	✔		139
Radiation Monitors					
Vernier Radiation Monitor	VRM-BTD	✔			140
Radiation Monitor (Digital)	DRM-BTD	✔			140
Relative Humidity Sensor	RH-BTA	✔	✔		140
Respiration Monitor Belt *(requires GPS-BTA)*	RMB	✔	✔		140
Rotary Motion Sensor	RMV-BTD	✔			141
Salinity Sensor	SAL-BTA	✔	✔		141
Soil Moisture Sensor	SMS-BTA	✔	✔		141
Sound Level Meter	SLM-BTA	✔	✔		142
Spectrometers					
SpectroVis Plus Spectrophotometer	SVIS-PL	✔		*USB*	142
NEW Vernier Emissions Spectrometer	VSP-EM	✔		*USB*	142
NEW Vernier UV-VIS Spectrometer	VSP-UV	✔		*USB*	143
Ocean Optics Spectrometers					
Vernier Spectrometer	V-SPEC	✔		*USB*	52
Spirometer	SPR-BTA	✔	✔		143
Temperature Probes					
EasyTemp *(calculators only)*	EZ-TMP			*USB*[3]	119
Extra-Long Temperature Probe	TPL-BTA	✔	✔		144
Go!Temp	GO-TEMP	✔		*USB*	21
NEW Go Wireless Temp	GW-TEMP	✔		*Wireless*[4]	144
Infrared Thermometer	IRT-BTA	✔	✔		144
Stainless Steel Temperature Probe	TMP-BTA	✔	✔		144
Surface Temperature Sensor	STS-BTA	✔	✔		144

SENSOR	CODE	LABQUEST 2/ MINI	GO!LINK/ EASYLINK	USB OR WIRELESS	PAGE
Temperature Probes (continued)					
Thermocouple	TCA-BTA	✔	✔		145
Wide-Range Temperature Probe	WRT-BTA	✔	✔		145
Turbidity Sensor	TRB-BTA	✔	✔		145
UVA Sensors					
UVA Sensor	UVA-BTA	✔	✔		146
UVB Sensor	UVB-BTA	✔	✔		146
Voltage Probes					
Differential Voltage Probe	DVP-BTA	✔	✔		146
Voltage Probe	VP-BTA	✔	✔		146
30-Volt Voltage Probe	30V-BTA	✔	✔		146
Watts Up Pro	WU-PRO	✔		*USB*	147
Wireless Dynamics Sensor System	WDSS	✔		*Wireless*[5]	147

[1] With calculators, TI-Nspire only [2] With computers only [3] Mini-USB for use with calculators
[4] Requires Bluetooth Smart support [5] Not for use with tablets

Accelerometers

3-Axis, Low-g and 25-g

We have three accelerometers designed for different uses. These small devices can be mounted on objects to study motion. All are individually calibrated.

3-Axis Accelerometer

ORDER CODE **3D-BTA**

Use this for studying the complex motion of an amusement park ride, a bungee jump, or simply a toss in the air.

RANGE: -50 to +50 m/s^2 **TYPICAL ACCURACY:** ±0.1 m/s^2

Low-g Accelerometer, ORDER CODE LGA-BTA

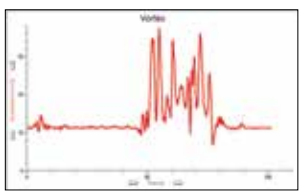
This is the best choice for most experiments. Use it for studying the one-dimensional motion of a car (real and toy), elevator, pendulum bob, or amusement park ride.

RANGE: -50 to +50 m/s^2 **TYPICAL ACCURACY:** ±0.1 m/s^2

25-g Accelerometer, ORDER CODE ACC-BTA

This is great for studying one-dimensional collisions or any motion with larger accelerations.

RANGE: -250 to +250 m/s^2 **TYPICAL ACCURACY:** ±1 m/s^2



Accelerations during the Vortex amusement park ride

See also WDSS on page 147.

GREAT WAYS TO USE THESE SENSORS!

PHYSICS
- Bungee jump accelerations
- Newton's second law
- Centripetal acceleration on a turntable
- Acceleration on a merry-go-round

HUMAN PHYSIOLOGY
- Neuromuscular reflexes

INNOVATIVE USES
- Accelerations on the half pipe
- Accelerations in snowboarding

Anemometer

ORDER CODE **ANM-BTA**

The Vernier Anemometer is an impeller-type anemometer that measures wind speed in the range of 0.5 to 30 m/s (1 to 67 mph). The Anemometer fits in your palm for wind study measurements in the field. A standard camera mount on the back and an accessory rod allows you to position it in wind tunnels or in front of fans for wind turbine experiments.

RANGE: 0.5 m/s to 30 m/s

RESOLUTION:
10-bit resolution (using CBL 2): 4.8 x 10^{-2} m/s
12-bit resolution (using LabQuest, LabQuest Mini, LabPro, Go!Link, EasyLink): 1.2 x 10^{-2} m/s

Using the Anemometer to measure wind speed

GREAT WAYS TO USE THIS SENSOR!

ENVIRONMENTAL SCIENCE
- Measure the wind speed of air
- Measure the effects of design on wind turbine's output
- Measure the effects on cooling rate
- Measure wind speed in wind tunnels
- Use with a compass to determine wind direction
- Investigate wind speed over land and water

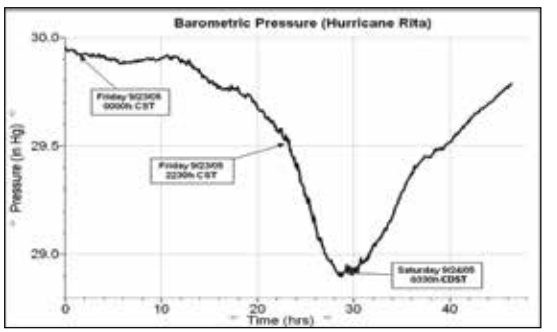
Barometer

ORDER CODE **BAR-BTA**

Our Barometer can be used for weather studies or for lab experiments involving pressures close to normal air pressure.

RANGE: 25.0 to 31.5 inHg 81 to 106 kPa
0.80 to 1.05 atm 600 to 800 mmHg

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.003 inHg
10-bit (CBL, CBL 2, NXT Adapter): 0.01 inHg



Atmospheric pressure data collected during Hurricane Rita in 2005

GREAT WAYS TO USE THIS SENSOR!

EARTH SCIENCE
- Barometric pressure
- Local weather study

INNOVATIVE USES
- Study the barometric pressure of storms
- Use it as an altimeter
- Study Bernoulli's principle

Blood Pressure Sensor

ORDER CODE
BPS-BTA

The Blood Pressure Sensor is a noninvasive sensor designed to measure human blood pressure.

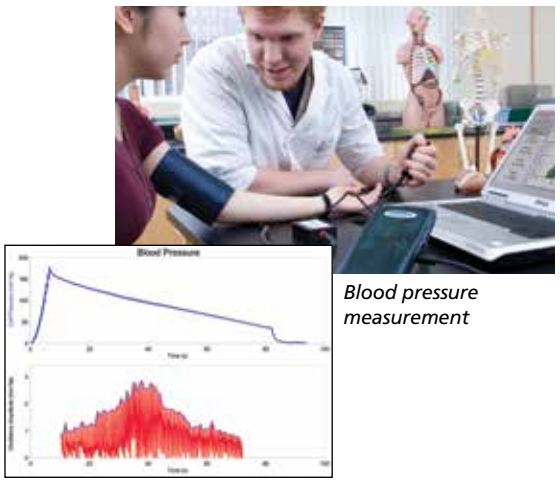
- Measures systolic and diastolic blood pressure utilizing the oscillometric technique.
- Includes a standard adult-size adjustable cuff (27 cm to 39 cm), pump bulb, and pressure transducer.

Additional cuff sizes are available for best results on small or large arms. Each includes cuff, pump, and valve.

Small Cuff, 18 cm to 27 cm, ORDER CODE **CUFF-SM**
Large Cuff, 35 cm to 51 cm, ORDER CODE **CUFF-LG**

PRESSURE RANGE: 20 mmHg to 250 mmHg

TYPICAL ACCURACY: ±3 mmHg



Blood pressure measurement

GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Blood pressure as a vital sign
- Effect of exercise on blood pressure
- Diurnal blood pressure variation
- Heart rate and blood pressure as vital signs
- Heart rate, blood pressure, and exercise

Charge Sensor

ORDER CODE
CRG-BTA

Use the Charge Sensor as an electronic electroscope to obtain quantitative measurements when studying charging by induction, friction, or contact.

- A 0.01 µF input capacitor makes it possible for this extremely high impedance voltage sensor to be used in many electrostatic experiments.
- Range switch allows you to adjust sensitivity.
- Zero switch discharges the input capacitor between runs.

RANGES: ±0.5 V (± 5 nC)
±2 V (± 20 nC)
±10 V (± 100 nC)

Typical bias current: 0.005 pA
Input capacitance: 0.01 µF

Electrostatics Kit

ORDER CODE **ESK-CRG**

The Electrostatics Kit is an accessory for the Charge Sensor. The kit includes a Faraday pail and cage, grounding plane, grounding wires and wrist strap, charge producers and proof plane, wool, vinyl, nylon rod, PVC rod, and a cotton cloth. See page 93.

High Voltage Electrostatics Kit

ORDER CODE **HVEK-CRG**

The Electrostatics Kit is an accessory for the Charge Sensor. The kit includes an electrostatics voltage source (output 750, 1500, 3000, 6000 V DC) and two conducting spheres. Extremely low output current makes this device safe for classroom use. See page 93.

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Use as electronic electroscope
- Charging by induction, by friction, and by contact
- Measure charge polarity

More innovative uses from teachers at **www.vernier.com/innovate**

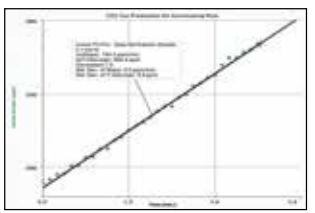
CO_2 Gas Sensor

ORDER CODE
CO2-BTA

The CO_2 Gas Sensor measures gaseous carbon dioxide in two ranges—0 to 10,000 ppm and 0 to 100,000 ppm.

- Explore human respiratory changes in CO_2 levels based on exercise with the high range.
- The lower range offers more sensitivity and a wider interval for cellular respiration and photosynthetic metabolism studies.

RANGE: Low 0–10,000 ppm
High 0–100,000 ppm



Measuring CO_2 levels of germinating peas

BioChambers

BioChambers provide a way for both CO_2 Gas and O_2 Gas Sensors, or one of these along with the Ethanol Sensor, to be used at the same time in a closed system.

BioChamber 2000, 2000 mL
ORDER CODE **BC-2000**

BioChamber 250, 250 mL
ORDER CODE **BC-250**

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY
- Cell respiration in peas
- Respiration of sugars by yeast
- Effect of temperature on cold-blooded organisms
- Photosynthesis and respiration
- Levels of CO_2 in human respiration
- Measure CO_2 along with O_2 in respiration and photosynthesis

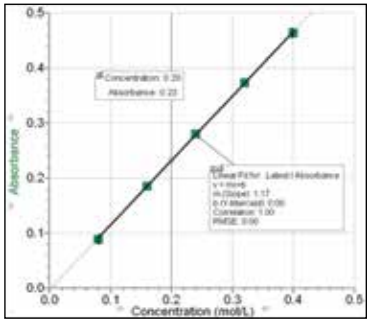
ENVIRONMENTAL SCIENCE
- Investigating indoor CO_2 concentrations

Colorimeter

ORDER CODE
COL-BTA

This 4-wavelength Colorimeter features one-button automatic calibration. Fifteen 3.5 mL cuvettes are included. A package of 100 replacement cuvettes (with 20 lids) is available (ORDER CODE CUV).

WAVELENGTHS: 430 nm 470 nm 565 nm 635 nm



Beer's law experiment

Cuvette Rack

ORDER CODE **CUV-RACK**

No more spills! Holds ten standard cuvettes.

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Beer's law: determining the concentration of unknown substances
- Kinetics: rate and order of a chemical reaction
- Rate determination and activation energy
- Chemical equilibrium: Finding a constant, K_c
- Rate law determination of the crystal violet reaction

BIOLOGY
- Photosynthesis
- The effect of alcohol on biological membranes
- Population dynamics

WATER QUALITY
- Ortho- and total-phosphates concentration

FORENSICS
- Identifying an unknown ink by its light absorbance characteristics

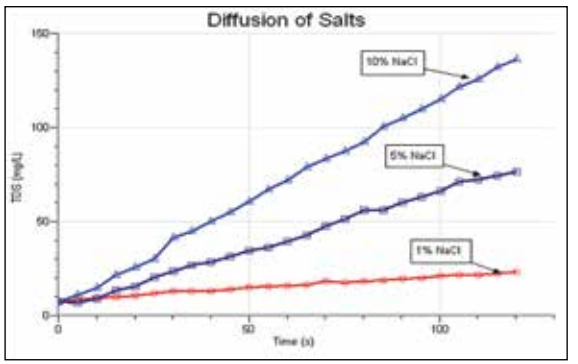
Conductivity Probe

ORDER CODE
CON-BTA

This probe measures the electrical conductivity of water. It is an important part of chemistry, biology, and water quality studies.

AUTOMATIC TEMPERATURE COMPENSATION: 5°C to 35°C

LOW RANGE:	MEDIUM RANGE:	HIGH RANGE:
0–200 µS/cm	0–2000 µS/cm	0–20000 µS/cm
(0–100 mg/L TDS)	(0–1000 mg/L TDS)	(0–10000 mg/L TDS)



Diffusion through membranes

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY
- Diffusion of ions through membranes
- Monitor changes in ion levels in aquatic systems
- Limitations of cell size: surface area to volume

MIDDLE SCHOOL
- Water hardness study
- Diffusion: how fast?

CHEMISTRY
- Investigate ionic and molecular compounds, strong and weak acids
- Conductimetric titrations
- Investigate ionic concentrations and conductivity levels

WATER QUALITY
- Total dissolved solids

PHYSICAL SCIENCE
- Acid strengths

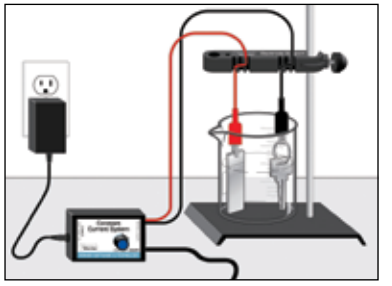
Constant Current System

ORDER CODE
CCS-BTA

The Constant Current System is a DC power source capable of delivering up to 0.6 A with a built-in current probe designed for use in electrochemistry experiments. The user can set the current by turning the dial with the system automatically adjusting the voltage.

Note: The Constant Current System works only with its own built-in power supply. It cannot be used to measure the current of a circuit using a different power supply.

RANGE: 0 to 0.6 A
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.18 mA



Electroplating a key

Electrode Support

ORDER CODE **ESUP**

Our Electrode Support is a perfect holder for many sensors. With our improved design, you can suspend the wire leads for your electroplating setup.

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Electroplating
- Determining Avogadro's number

Current Probes

Current Probe

ORDER CODE
DCP-BTA

Use the Current Probe to measure currents in low-voltage AC and DC circuits. With a range of ±0.6 A, this probe is ideal for use in most battery and bulb circuits. Use multiple sensors to explore series and parallel circuits. It can also be used in electrochemistry experiments.

RANGE: -0.6 to +0.6 A **SENSE RESISTOR:** 0.1 Ω
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.3 mA
10-bit (CBL, CBL 2, NXT Adapter): 1.25 mA

Studying Ohm's law using the Current Probe, Differential Voltage Probe, and the Vernier Circuit Board

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Electroplating
- Determining Avogadro's number

ENVIRONMENTAL SCIENCE
- Solar energy: photovoltaic cells
- Wind energy

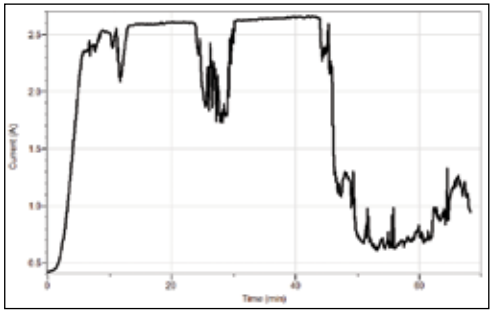
PHYSICS
- Ohm's law
- Series and parallel circuits
- Electrical energy

High Current Sensor

ORDER CODE
HCS-BTA

The High Current Sensor is used to measure current in the range of ±10 A. The sensor uses a Hall effect chip, so that it does not add a resistive element to your circuit. A metal shield over the Hall effect chip reduces the influence of external magnets. A replaceable fuse protects the equipment and circuit.

RANGE SETTINGS: 10 A; maximum voltage input 40 V
RESOLUTION:
12-bit resolution (LabQuest, LabQuest Mini, LabPro, Go!Link): 4.9 mA



Current produced by a large solar panel vs. time

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Record currents from a solar panel
- Record currents from popular hand-held generators
- Record current in do-it-yourself projects with larger current, such as wind generators

IMPROVED

Digital Control Unit

ORDER CODE
DCU-BTD

The Digital Control Unit (DCU), combined with new features in Logger *Pro*, makes control of electrical devices, such as buzzers, lights, motors, pumps, and relays, both straightforward and flexible. The DCU is a great way to introduce hands-on STEM and engineering projects.

Included is a manual that contains
- Project ideas using Logger *Pro*
- Explanations of how to write LabVIEW programs for the DCU and SensorDAQ or LabQuest
- Wiring diagrams

Using a Digital Control Unit to control an automated light tracker

DCU Power Supply, ORDER CODE IPS

Note: The Digital Control Unit does not work with LabQuest App but will work with LabQuest and Logger *Pro* 3.7, and newer.

GREAT WAYS TO USE THIS SENSOR!

ENGINEERING
- Turn on motors or buzzers
- Make an alarm system
- Make a robot
- Create temperature-controlled environments
- Moving displays
- Flash lamps on LEDs

Dissolved Oxygen Probes

Vernier Optical DO Probe

ORDER CODE
ODO-BTA

The Vernier Optical DO Probe makes it easy to measure the dissolved oxygen concentration in water. Perfect for the field or for the laboratory, this plug-and-play probe requires no calibration, no filling solution, no warm-up time, and no stirring.

See page 39 for accessories137

Dissolved Oxygen Probe

ORDER CODE
DO-BTA

Use the original Dissolved Oxygen Probe to determine the concentration of oxygen in aqueous solutions.

- Built-in temperature compensation and a fast response time.
- Includes zero-oxygen solution, two caps fitted with membranes, a 100% calibration bottle, and electrode filling solution.

AUTOMATIC TEMPERATURE COMPENSATION: 5°C to 35°C

RANGE: 0 to 14 mg/L

See page 39 to help determine which DO probe is right for you.

GREAT WAYS TO USE THESE SENSORS!

BIOLOGY
- Interdependence of plants and animals
- Aerobic respiration
- Dissolved oxygen *vs.* time
- Watershed testing
- Physical profile of a lake
- Primary productivity

WATER QUALITY
- Dissolved oxygen concentration
- Biochemical oxygen demand (BOD)

ENVIRONMENTAL SCIENCE
- Long term water monitoring
- Investigating dissolved oxygen

IMPROVED Drop Counter

ORDER CODE
VDC-BTD

Use the Drop Counter with our pH Sensor, Conductivity Probe, or ORP Sensor to easily perform acid-base, conductimetric, or potentiometric titrations. The Vernier Drop Counter has many features that help simplify its use:

- Wide drop-detecting area
- Red LED, near the detecting area, flashes to indicate a drop has been recorded
- Accurate drop counting at rates up to 6 drops/second
- Adjustable clamp; fits most laboratory ring stands and lattices
- Large sensor slot; fits most conventional stick-style sensors
- Smaller, adjustable slot for temperature sensors
- Precisely records the number of drops of titrant added during a titration, which is automatically converted into volume
- Includes a cable, Microstirrer (shown below), and reagent reservoir

A Microstirrer is included with the Drop Counter. Additional Microstirrers are available (ORDER CODE MSTIR).

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Acid-base titration
- Standardizing a solution of sodium hydroxide
- Oxidation-reduction titration
- Investigating indicators
- Conductimetric titration and gravimetric determination of a precipitate
- Potentiometric titration of hydrogen peroxide

Dual-Range Force Sensor

ORDER CODE
DFS-BTA

Our Dual-Range Force Sensor can be easily mounted on a ring stand or dynamics cart or used as a replacement for a hand-held spring scale. It has two ranges: ±10 N and ±50 N and resolution of 0.01 N and 0.05 N, respectively.

Dual-Range Force Sensor Accessories

Bumper and Launcher Kit, ORDER CODE **BLK**
See page 95 for more information.

Air Track Adapter, ORDER CODE **ATA-DFS**
Allows the Dual-Range Force Sensor to be mounted on the end of an air track for collision studies. Compatible with most air tracks. Includes two magnetic bumpers.

Force Table Adapter, ORDER CODE **FTA-DFS**
Use your Dual-Range Force Sensor with your force table for resolution of vectors experiments. Includes mounting clamp.

Mass For Dynamics Cart, ORDER CODE **MASS**
This 500 g steel block is a great accessory for Newton's second law labs. It attaches to a dynamics cart and leaves room for both a Dual-Range Force Sensor and an Accelerometer.

GREAT WAYS TO USE THESE SENSORS!

PHYSICS
- Newton's second law
- Newton's third law
- Static and kinetic friction
- Impulse and momentum

PHYSICAL SCIENCE
- Frictional forces
- Pulleys

MIDDLE SCHOOL
- Friction
- First-class levers

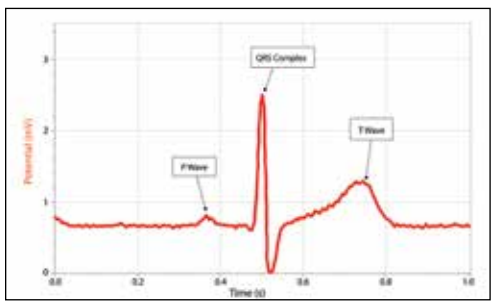
EKG Sensor

ORDER CODE
EKG-BTA

Use the EKG Sensor to measure electrical signals produced during muscle contractions.

- Make standard 3-lead EKG tracings to record electrical activity in the heart.
- Collect surface EMG recordings to study contractions in muscles in your arm, leg, or jaw.

Each sensor includes a package of 100 disposable electrodes. Additional packages of 100 electrodes are available (ORDER CODE ELEC).



EKG graph demonstrating the contraction and repolarization of the heart's chambers

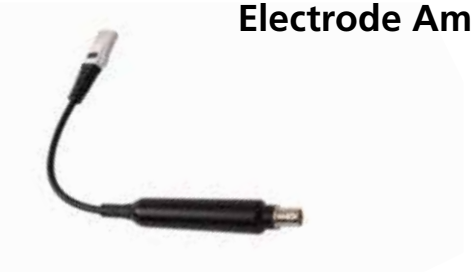
GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Analyzing the heart with EKG
- Introduction to EMG
- Neuromuscular reflexes
- Muscle function analysis
- EMG and muscle fatigue

BIOLOGY
- Monitoring EKG

INNOVATIVE USE
- Monitor the heart rate of crawfish

Electrode Amplifier



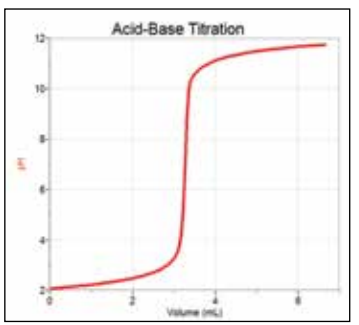
ORDER CODE
EA-BTA

This sensor is a mV/pH/ORP amplifier that accepts an electrode with a standard BNC connector. It amplifies a –450 mV to +1100 mV signal to a 0 to 5 V range.

It can be used with any of the following:

- Vernier BNC pH Electrode (ORDER CODE 7120B)
- Most third-party pH electrodes (with BNC connectors)
- Other high output impedance electrodes
- Most third-party ORP electrodes (with BNC connectors)

See page 138 for our pH Sensor options.



Acid-base titration curve

BUY WITH CONFIDENCE

Our 5-year warranty on most Vernier products gives you a superior level of buying confidence. In fact, in Vernier's 33 years of business, we have rarely charged a customer for a repair, no matter how old the equipment!

Ethanol Sensor

ORDER CODE
ETH-BTA

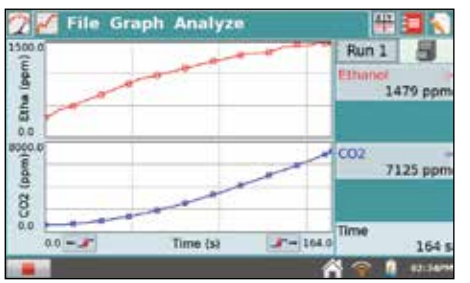
The Ethanol Sensor measures the concentration of ethanol in the air above an aqueous sample.

This sensor has a wide variety of applications.

- Measure the rate of ethanol production by yeast.
- Determine if specific organisms can utilize ethanol fermentation as a metabolic pathway.
- Determine which sugars yeast are able to ferment.
- Investigate variables that increase or decrease the rate of ethanol production.
- Investigate variables that increase or decrease the rate of ethanol production.

RANGE: 0% to 3%

RESOLUTION:
12-bit (LabQuest 2, LabQuest, LabQuest Mini, LabPro, TI-Nspire Lab Cradle): 0.02% from 2-3%, 0.01% from 1-2%, 0.001% from 0-1%
10-bit (CBL 2): 0.04% from 2-3%, 0.02% from 1-2%, 0.002% from 0-1%



Measuring CO_2 gas and ethanol production during fermentation

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY
- Determine which sugars yeast can metabolize
- Observe ethanol and CO_2 production during fermentation

CHEMISTRY
- Measure the concentration of ethanol in a sample

Flow Rate Sensor

ORDER CODE
FLO-BTA

Use the Flow Rate Sensor to easily measure stream velocity for environmental or Earth science studies. Flow rate data can be used to calculate the discharge value for the stream or study the sediment transport of the stream.

- Separates into four sections for easy transport and convenient storage.
- Equipped with a 5 m cable, so your data-collection equipment can stay on shore.
- Includes 3 riser rods, which enable the impeller to be placed at fixed depths.

RANGE: 0 to 4 m/s

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.0012 m/s
10-bit (CBL, CBL 2, NXT Adapter): 0.005 m/s

Collecting flow rate data with a LabQuest

GREAT WAYS TO USE THIS SENSOR!

WATER QUALITY
- Measure stream flow rates
- Investigate sediment transport
- Determine stream discharge values

Force Plate

ORDER CODE
FP-BTA

The Force Plate is a large force sensor—tough enough to jump on. About the size and shape of a bathroom scale, the Force Plate has two ranges, one reading up to 3500 N and the other to 800 N. Two handles are included for pushing or pulling. Additional pairs of handles are available (ORDER CODE FP-HAN).

RANGE: -850 to 3500 N and -200 to 850 N

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 1.2 N or 0.3 N
10-bit (CBL, CBL 2, NXT Adapter): 4.8 N or 1.2 N

Studying Newton's third law

*Additional shipping charges may apply due to weight

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Study the dynamics of jumping and walking
- Study how the normal force on your feet changes during an elevator ride
- Try pushing a car across the parking lot
- Use two Force Plates to study Newton's third law

Gas Pressure Sensor

ORDER CODE
GPS-BTA

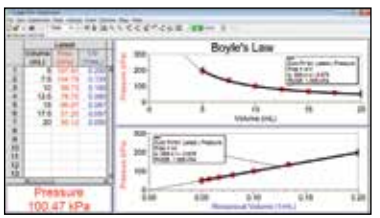
The Gas Pressure Sensor has sufficient resolution and range to work for many subject areas:

Chemistry
- Wide enough range for Boyle's law experiments.
- Sufficient resolution for vapor-pressure or pressure-temperature experiments.

Biology
- Use the included airtight tubing clamps for transpiration experiments.
- Perform respiration experiments in small containers using included fittings.

Includes the Pressure Sensor Accessories Kit (shown above). For replacement parts, see page 149.

RANGE: 0 to 210 kPa (0 to 2.1 atm or 0 to 1600 mmHg)



Studying Boyle's law

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY
- Transpiration
- Enzyme action: testing catalase activity
- Sugar fermentation

PHYSICAL SCIENCE
- Gas pressure and volume
- Gas temperature and pressure

MIDDLE SCHOOL
- Get a grip!
- Fun with pressure

CHEMISTRY
- Boyle's law
- Pressure-temperature
- Volume-temperature relationship in gases
- Vapor pressure of liquids
- Ideal gas law investigation

MATH
- Under pressure: the inverse relationship between pressure and volume

Goniometer

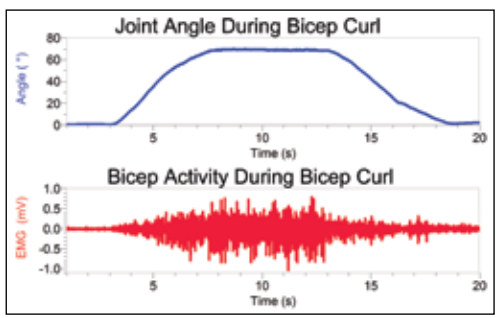
ORDER CODE
GNM-BTA

The Goniometer can be used to measure the dynamic motion of a limb during different types of physical activity.

- A set of elastic straps are used to secure the sensor to the subject.
- The lightweight and flexible joint arms allow the limb to move naturally.
- Use it with an EKG Sensor to measure muscle activity during limb motion.
- The sensor can also be detached from the base plate and flexible arms, so it can be used in a variety of STEM and engineering activities.

RANGE: 0 to 340° (±170°)

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.05°
10-bit (CBL, CBL 2, NXT Adapter): 0.12°



Using a Goniometer and EKG Sensor to measure joint angle and muscle activity

GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Monitor joint angle
- Determine range of motion
- Muscle function analysis

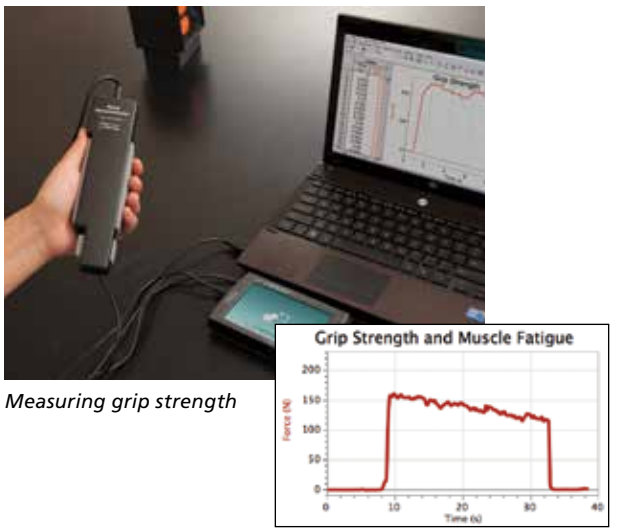
ENGINEERING
- Propeller-powered pendulum

Hand Dynamometer

ORDER CODE
HD-BTA

Our strain-gage based isometric dynamometer can be used to measure grip strength or finger-pinch strength. The Hand Dynamometer can be used alone or in combination with EMG recordings for detailed studies of muscular activity.

FORCE RANGE: 0 to 600 N **TYPICAL ACCURACY:** ±0.6 N



Measuring grip strength

GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Grip strength comparison
- Grip strength and muscle fatigue
- EMG and muscle strength
- Measure pinch strength in fingers

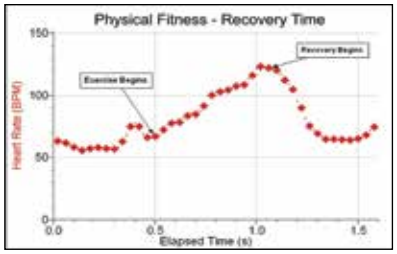
Hand-Grip Heart Rate Monitor

ORDER CODE
HGH-BTA

The Hand-Grip Heart Rate Monitor is ideal for continuously monitoring heart rate before, during, and after exercise or while a person is stationary.

- Hand grips do not require electrodes or clips.
- Easily shared between students.

Hand grips detect electrical pulses generated by the heart, wirelessly transmit a signal to the receiver module, and the individual's pulse or heart rate is calculated.



Recovery rate determined by monitoring heart rate

Chest Belt Transmitter

ORDER CODE **CBT**

You can use our Chest Belt Transmitter in conjunction with the Hand-Grip Heart Rate Monitor's receiver for a hands-free option of measuring heart rate.

GREAT WAYS TO USE THESE SENSORS!

HUMAN PHYSIOLOGY
- Heart rate as a vital sign
- Heart rate and exercise
- Heart rate and blood pressure as vital signs
- Effect of coughing on heart rate
- Response to baroreceptor feedback

MIDDLE SCHOOL
- Heart rate and body position
- Heart rate and exercise

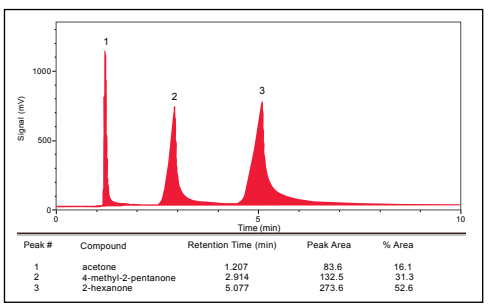
BIOLOGY
- Heart rate and physical fitness
- Ventilation and heart rate

Instrumentation Amplifier

ORDER CODE
INA-BTA

The Instrumentation Amplifier is used to amplify small signals so they can be measured with a Vernier interface. The input bandwidth of 10 kHz allows the capture of higher frequency signals. The Instrumentation Amplifier monitors voltages from 20 mV to 1 V full scale (DC or AC). It has six switch settings to allow you to select the best gain. It is often used to amplify the chart recorder or analog output of any instrument, such as a third-party gas chromatograph. You can also use the Instrumentation Amplifier to measure small induced currents in coils.

RANGE SETTINGS: 0–20 mV, 0–200 mV, 0–1 V, ±20 mV, ±200 mV, ±1 V



Peak #	Compound	Retention Time (min)	Peak Area	% Area
1	acetone	1.207	83.6	16.1
2	4-methyl-2-pentanone	2.914	132.5	31.3
3	2-hexanone	5.077	273.6	52.6

Data collected using an Instrumentation Amplifier attached to a third-party gas chromatograph

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Investigating resistivity
- Use to amplify signals from third-party laboratory instruments
- Use to replace a strip-chart recorder for recording instrument data

Ion-Selective Electrodes

ORDER CODE
SEE BELOW

Our Ion-Selective Electrodes (ISEs) are for monitoring five environmentally important ions: Nitrate (NO_3^-), Chloride (Cl^-), Calcium (Ca^{2+}), Ammonium (NH_4^+), and Potassium (K^+).

- The Nitrate, Calcium, Potassium, and Ammonium ISEs are combination-style, non-refillable, and gel-filled. The Chloride ISE is a solid state device; it does not have a replacement module.
- Vernier ISE membranes, like all other PVC ISE membranes, have a limited life expectancy. However, the replaceable module of Vernier ISEs allows you to simply discard the used membrane module, and replace it with a new one. To purchase replacement modules, see page 149.
- Included with each ISE are two calibration standards and a short-term soaking bottle. To purchase additional standards, see page 149.

AMMONIUM ISE:
RANGE: 0.1 to 18,000 mg/L or ppm

CALCIUM ISE:
RANGE: 0.2 to 40,000 mg/L or ppm

CHLORIDE ISE:
RANGE: 1.8 to 35,000 mg/L or ppm

NITRATE ISE:
RANGE: 0.1 to 14,000 mg/L or ppm

POTASSIUM ISE:
RANGE: 90 to 39,000 mg/L or ppm

Ammonium ISE
ORDER CODE **NH4-BTA**

Calcium ISE
ORDER CODE **CA-BTA**

Chloride ISE
ORDER CODE **CL-BTA**

Nitrate ISE
ORDER CODE **NO3-BTA**

NEW Potassium ISE
ORDER CODE **K-BTA**

Ion-Selective Electrodes require good chemical technique and careful calibration to obtain accurate results. They are not recommended for middle school or elementary school students. ISE modules are covered by a one-year warranty.

GREAT WAYS TO USE THESE SENSORS!

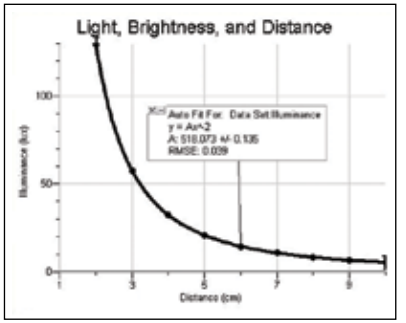
WATER QUALITY
- Calcium and water hardness
- Chloride and salinity
- Monitor ammonium concentration
- Monitor nitrate concentration

Light Sensor

ORDER CODE
LS-BTA

Our Light Sensor approximates the human eye in spectral response and can be used over three different illumination ranges that you select with a switch. Use it for inverse-square law experiments or for studying polarizers, reflectivity, or solar energy.

LOW RANGE:	MEDIUM RANGE:	HIGH RANGE:
0 to 600 lux	0 to 6000 lux	0 to 150,000 lux



Inverse square law of light

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Polarization of light
- Inverse square law

PHYSICAL SCIENCE
- Reflectivity of light
- Polaroid filters
- How bright is the light?

MATH
- Inverse square relationship
- Periodic phenomena

MIDDLE SCHOOL
- Reflectivity of light
- Schoolyard study

EARTH SCIENCE
- Reflection and absorption of light
- Photovoltaic cells
- Measuring particulates

Magnetic Field Sensor

ORDER CODE
MG-BTA

Use the Magnetic Field Sensor to study the field around permanent magnets, coils, and electrical devices.

- Sensitive enough to measure the Earth's magnetic field.
- Rotating tip allows you to measure both transverse and longitudinal magnetic fields.

LOW SENSITIVITY:	HIGH SENSITIVITY:
RANGE: -6.4 to +6.4 millitesla (mT)	**RANGE:** -0.32 to +0.32 mT

Measuring the magnetic field in a coil

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- The magnetic field in a coil
- The magnetic field in a slinky
- The magnetic field of a permanent magnet

PHYSICAL SCIENCE
- Electromagnets

MIDDLE SCHOOL
- Mapping a magnetic field

EARTH SCIENCE
- Exploring magnetism
- Where is north?
- Searching for iron ore

Melt Station

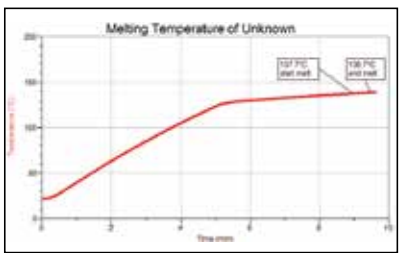
ORDER CODE
MLT-BTA

Our Melt Station is used to measure the melting temperature of solid substances.

- Accurate results using built-in RTD over a range of 20°C to 260°C
- High-quality 6X viewing lens for clear observation of the samples
- Innovative, adjustable tilt allows for optimal viewing angle
- Cooling fan reduces time between tests

Each Melt Station comes with 100 standard capillary tubes. Additional packages of 100 are available, (ORDER CODE MLT-TUBE).

RANGE: 20°C to 260°C
ACCURACY: ± 0.2°C up to 200°C, ± 0.4°C above 200°C
CALIBRATION: factory calibrated
POWER: separate AC power supply (included)
DIMENSIONS: 9 cm × 11 cm × 26 cm
FOOTPRINT: 13 cm × 15 cm



Sample graph of temperature vs. time marking the melting temperature

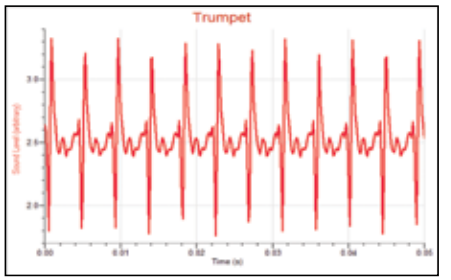
GREAT WAYS TO USE THIS SENSOR!

ORGANIC CHEMISTRY
- Determining melting temperature
- Recrystallization of benzoic acid and aspirin
- Identifying unknown analgesic
- Separation of organic compounds
- Synthesis of dibenzalacetone by aldol condensation

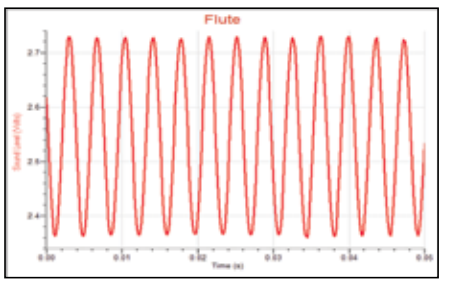
Microphone

ORDER CODE
MCA-BTA

Use our Microphone to display and study the waveforms of sounds from voices and musical instruments. It is also appropriate for speed of sound experiments.



Waveform of a trumpet



Waveform of a flute

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Sound waves and beats
- Tones, vowels and telephones
- Investigate musical scales
- Speed of sound

MATH
- Sound waveform modeling

FORENSICS
- Identify the musical notes that make up the combination to a safe

Mini GC Plus

ORDER CODE
GC2-MINI

Use the Vernier Mini GC Plus gas chromatograph to separate and identify even more compounds than the original Mini GC, while still using air as the carrier gas. Perform analysis and peak integration using LabQuest as a standalone device or with Logger *Pro* software on a computer. The Mini GC Plus is covered by a two-year warranty (syringe, column, sensor, and septa excluded). More details on page 49.

FAMILIES OF COMPOUNDS THAT CAN BE USED IN THE MINI GC PLUS:
Alcohols, aldehydes, substituted aromatic hydrocarbons, carboxylic acids, chlorinated hydrocarbons, esters, ethers, ketones, nitriles, and more.

MEMS DETECTOR:
The unique Seacoast Science MEMS Chemi-Capacitive Detector is state-of-the-art technology that allows air to be used as the carrier gas.

COLUMN:
High-quality Restek MXT-1 stainless steel capillary column (11 meter)

TEMPERATURE REGULATION:
Software-controlled temperature regulation from 30–160°C

COLUMN TEMPERATURE RAMP:
- Maximum of 10°C/minute
- Short warm-up time: <10 minute max for most labs

PRESSURE REGULATION:
Software-controlled pressure regulation from 1–21 kPa above ambient

INJECTION:
- Comes with one high-quality 1 µL Hamilton syringe
- Injection is direct from syringe to column
- Liquid injection volume: 0.01 to 0.50 µL

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Using a gas chromatograph: identifying unknown compounds
- Verification of esterification
- Quantifying substances in a mixture
- Fractional distillation
- Investigating gas chromatography

ORGANIC CHEMISTRY
- Fractional distillation of esters
- Enthalpy of vaporization

NEW Vernier Motion Encoder System

The Motion Encoder System is a revolutionary way for physics students to study dynamics. Optical position measurement means the end to setup frustration, keeping the focus on the physics.

Vernier Motion Encoder System
ORDER CODE **VDS-EC**
This is a complete dynamics system, including a Motion Encoder Cart and Receiver.

Motion Encoder Upgrade Kit
ORDER CODE **MEU-VDS**
Includes Motion Encoder Cart parts, Receiver, and Motion Encoder Track Strip. Purchase this kit to upgrade your existing Vernier Dynamics System to a Motion Encoder System. One-time assembly required to modify your Cart.

Motion Encoder Cart and Receiver
ORDER CODE **MEC-VDS**
Includes complete Motion Encoder Cart, Receiver, and Motion Encoder Track Strip. Add the Motion Encoder Cart and Receiver to an existing Vernier Dynamics System to upgrade it to a Motion Encoder System. No assembly required.

For more details, see pp. 96–97.

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Cart on a ramp
- Newton's second law
- Conservation of momentum
- Momentum-impulse theorem
- Friction
- Back and forth motion

Motion Detectors

Motion Detector

ORDER CODE
MD-BTD

The Motion Detector uses ultrasound to measure the position of carts, balls, people, and other objects.
- Measure objects as close as 15 cm and as far away as 6 m.
- Sensitivity switch reduces noise and produces higher quality data for studying dynamics carts on tracks.
- Attaches easily to the Vernier Dynamics System.
- Pivoting head allows for flexibility in the experimental setup.
- Can be used with LabQuest, LabQuest 2, LabQuest Mini, LabPro, and CBL 2. Not supported with Go!Link or EasyLink.

RANGE:	RESOLUTION:	SENSITIVITY:
0.15 to +6 meters	1 mm	2 settings

Go! Motion

ORDER CODE
GO-MOT

The Go!Motion has the same features as our Motion Detector but connects directly to your computer or LabQuest by USB—no other equipment is needed.

RANGE:	RESOLUTION:	SENSITIVITY:
0.15 to +6 meters	1 mm	2 settings

Motion Detector Clamp
ORDER CODE **MD-CLAMP**
The Motion Detector Clamp attaches to the back of the Motion Detector or Go! Motion. The clamp can be attached to a variety of objects, such as table tops and ring stands.

O_2 Gas Sensor

ORDER CODE
O2-BTA

The O_2 Gas Sensor measures oxygen concentration in air. The wide measurement range allows it to be used to study human and cellular respiration.

- Perform or complement many experiments conducted using the CO_2 Gas Sensor.
- Includes a 250 mL bottle that can be used to study the rusting of iron or as a respiration chamber for monitoring plants and insects.

The electrochemical cell in the O_2 Gas Sensor is covered by a 5-year warranty, but has a life expectancy of 6–8 years. This cell can only be replaced in units of the style pictured above. Contact Vernier for information and pricing.

RANGE: 0 to 27% (0 to 270 ppt)
Normal operating temp range: 25°C (±5°C)
Operating temp range: 5-40°C (with calibration)
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.01%
10-bit (CBL, CBL 2, NXT Adapter): 0.04%

BioChambers

BioChambers provide a way for both CO_2 Gas and O_2 Gas sensors to be used at the same time in a closed system.

BioChamber 2000, 2000 mL
ORDER CODE **BC-2000**

BioChamber 250, 250 mL
ORDER CODE **BC-250**

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY
- Enzyme action: testing catalase activity
- Cell respiration in peas
- Effect of temperature on cold-blooded organisms
- Oxygen gas and human respiration
- Photosynthesis and respiration
- Measure O_2 along with CO_2 in photosynthesis and respiration

HUMAN PHYSIOLOGY
- Oxygen and aerobic metabolism
- Oxygen and extraction by the lungs
- Effect of "dead space" on oxygen availability

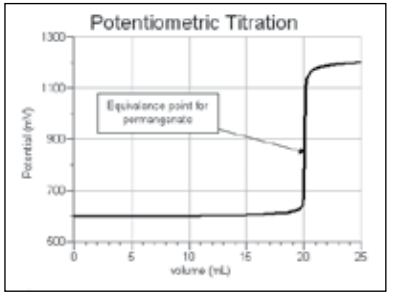
ORP Sensor

ORDER CODE
ORP-BTA

The Oxidation-Reduction Potential (ORP) Sensor lets you measure the ability of a solution to act as an oxidizing or reducing agent.

- Measure the oxidizing ability of chlorine in swimming pools or determine when the equivalence point has been reached in an oxidation-reduction reaction.
- Amplifier included.

REDOX POTENTIAL RANGE: -450 to +1100 mV
TEMPERATURE RANGE: 0 to 60°C (not compensated)



ORP mV vs. *volume data for the titration of hydrogen peroxide solution with potassium permanganate*

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- An oxidation-reduction titration: the reaction of Fe^{2+} and Ce^{4+}
- Potentiometric titration of hydrogen peroxide and permanganate
- Measure oxidizing potential of chlorine in swimming pools

NEW PAR Sensor

ORDER CODE
PAR-BTA

The PAR (Photosynthetically Active Radiation) Sensor measures photosynthetic light levels in both air and water. It features a waterproof sensor head and can be used to measure Photosynthetic Photon Flux Density (PPFD) from sunlight and electric light sources. It is sensitive to visible light in the spectral range that is used by plants in photosynthesis (400–700 nm). This sensor is ideal for experiments investigating photosynthesis and primary productivity and can also be used in many agricultural and environmental science applications.

PAR RANGE: 0 to 2000 µmol m^{-2} s^{-1} in full sun
ABSOLUTE ACCURACY: ±5%
REPEATABILITY: ±1%
LONG-TERM DRIFT: Less than 3% per year
COSINE RESPONSE: 45° zenith angle: 1%
75° zenith angle: ±5%
WAVELENGTH RANGE: 410 nm to 655 nm
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, Go!Link, LabPro): 1 µmol m^{-2} s^{-1}

Measuring photosynthetically active radiation (PAR) in a park

GREAT WAYS TO USE THIS SENSOR!

ENVIRONMENTAL SCIENCE
- Monitor the photosynthetic energy from the sun
- Compare the photosynthetic energy of artificial light sources
- Monitor the photosynthetic energy from the sun in different environments
- Compare photosynthetic energy at different depths

pH Sensor

ORDER CODE
PH-BTA

Our general purpose pH Sensor is an Ag-AgCl combination electrode. It can be used across disciplines, including chemistry, biology, middle school science, and environmental science.

- Includes a convenient soaking bottle and storage solution.
- pH Buffer Capsules (ORDER CODE PHB) and pH Storage Solution (ORDER CODE PH-SS) are available.

TYPE: Sealed, gel-filled, epoxy body, Ag/AgCl
RANGE: pH 0–14
TEMPERATURE RANGE: 5 to 80°C (not compensated)

Tris-Compatible Flat pH Sensor

ORDER CODE
FPH-BTA

This specialty pH Sensor uses a double-junction electrode, making it compatible with Tris buffers and solutions containing proteins. The flat glass shape also makes it ideal for measuring the pH of semisolids such as soft food or soil.

GREAT WAYS TO USE THESE SENSORS!

pH SENSOR

CHEMISTRY
- Acid-base titration
- Titration of a diprotic acid: identifying an unknown
- Acid dissociation constant, K_a
- Investigating indicators
- Investigating buffers

PHYSICAL SCIENCE
- Household acids and bases
- Acid rain

BIOLOGY
- Interdependence of plants and animals
- Watershed testing

TRIS-COMPATIBLE FLAT pH SENSOR

AGRICULTURAL SCIENCE
- Soil pH

BIOLOGY
- Applications involving Tris buffers or proteinaceous solutions

EARTH SCIENCE
- Soil pH
- Soil and acid rate

Photogate and Accessories

Photogate

ORDER CODE
VPG-BTD

Use the Vernier Photogate to study free fall, rolling objects, collisions, and pendulums.

- Use the built-in laser detector to create a photogate through which you could drive a truck.
- Connect up to four gates in a chain.
- Includes an accessory rod for attachment to a ring stand or for adding the Ultra Pulley Attachment.

Photogate Accessories

Ultra Pulley Attachment
ORDER CODE **SPA**
Add an Ultra Pulley to your Photogate to monitor motion as a string passes over the pulley or as the pulley rolls along a table.

Picket Fence
ORDER CODE **PF**
Our Picket Fence has 8 opaque bars silk-screened at intervals of 5 cm directly onto clear plastic. These devices are especially good for dropping through a photogate to study free fall.

Cart Picket Fence
ORDER CODE **PF-CART**
Attaches to Vernier Dynamics Carts.

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Determining the acceleration due to gravity
- Determining the speed of a rolling object
- Measure acceleration in an Atwood's machine
- Measure pendulum periods

Laser Pointer
ORDER CODE **LASER**
This Class IIIa (<5 mW) laser pointer can be used with the Vernier Photogate to produce a gate that is wider than the normal 7.5 cm spacing, making it possible to measure the speed of an automobile or of a person running. The laser case is made of aircraft aluminum and uses two AAA batteries (included). The wavelength of the light is 650 nm.

Laser Pointer Stand
ORDER CODE **STAND**
This light-weight tripod is a perfect support for the laser described above, which has a 1.1 cm outside diameter. The stand features fold-out legs and a clip attached to the adjustable ball. A socket head assembly securely holds the laser in place. This assembly allows you to accurately point the laser at the photogate. A hook-and-pile strap, integrated into one of the tripod legs, allows you to attach the laser to objects, such as ring stands and railings.

Pulley Bracket
ORDER CODE **B-SPA**
The Pulley Bracket attaches an Ultra Pulley to the end of a Vernier Dynamics Track.

Photogate Bar Tape Kit
ORDER CODE **TAPE-VPG**
The Photogate Bar Tape Kit contains a flexible plastic tape called "Bar Tape" and a guide that allows the tape to be used with a Vernier Photogate. The tape can be attached to objects and pulled through the photogate. This allows you to perform experiments much like what you would do with a ticker tape timer.

Polarimeter (Chemical)

ORDER CODE
CHEM-POL

The Chemical Polarimeter is an instrument used for measuring the rotation of plane-polarized light caused by an optically active substance. The Polarimeter is a vertical polarimeter that uses a yellow LED at 589 nm, a fixed polarizer, and a rotating polarizer (also called an analyzer) to detect changes in rotation of plane-polarized light in the presence of an optically active compound. One sample cell is included.

RANGE: ±180°
RESOLUTION*: 0.25°
LIGHT SOURCE: LED
WAVELENGTH: 589 nm
*This is the resolution of the analyzer. Typical absolute optical rotation measurements have a repeatability of ±1°.

Polarimeter Sample Cells

ORDER CODE **CELLS-POL**

Package of four replacement sample cells for the Chemical Polarimeter.

Product Specifications:

- Flat-bottom glass tube
- 20 mm inner diameter x 150 mm tall
- Screen-printed ruler with centimeter markings
- Pour spout

GREAT WAYS TO USE THIS SENSOR!

BIOLOGY/CHEMISTRY
- Determine sugar solution purity by optical rotation
- Characterize purity of inorganic syntheses yielding chiral products
- Study the kinetics of acid-catalyzed hydrolysis
- Study kinetics of enzyme-catalyzed hydrolysis
- Explore the optical activity of amino acids

ORGANIC CHEMISTRY
- Investigate reactions of natural products by optical rotation
- Characterize purity of organic syntheses yielding chiral products
- Determine enantiometric purity of optically active compounds

Power Amplifier

ORDER CODE
PAMP

Drive loads with ±10V and currents up to 1A with the Vernier Power Amplifier. The Vernier Power Amplifier works with any waveform. The Power Amplifier can drive a variety of loads, including speakers, lamps, motors, and circuits.

- Utilizes internal feedback for accurate AC waveforms and DC levels.
- Provides a steady, linearly controlled DC output for driving loads like DC motors and precise AC waveforms for driving things like speakers.
- Current limited to protect against overload and shorting.
- Current monitor function logs current.
- Class A-B push-pull amplifier provides low distortion with good efficiency.
- Works with LabQuest, LabPro, and SensorDAQ

OUTPUT VOLTAGE SWING (AMPLITUDE): ±10 V
MAX. OUTPUT CURRENT: 1 A
FREQUENCY RESPONSE: DC-20 kHz (-3 db @ 20 kHz, flat to ~15 kHz)
OUTPUT IMPEDANCE: <1 Ω

Power Amplifier Accessory Speaker

ORDER CODE **PAAS-PAMP**

This kit includes a speaker and accessories used with the Vernier Power Amplifier to study mechanical waves and springs. The speaker contains a light weight metal disc glued to the speaker cone.

GREAT WAYS TO USE THIS SENSOR!

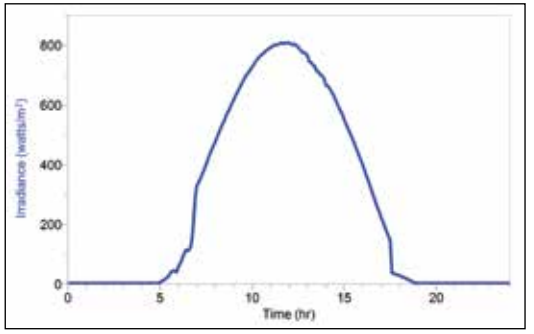
PHYSICS
- Produce standing wave patterns by vibrating one end of a string
- Investigate longitudinal resonance by oscillating a spring with a mass attached
- Study how resistance changes with heat by supplying a low frequency waveform to a incandescent lamp
- Study RC and RLC circuits

Pyranometer

ORDER CODE
PYR-BTA

The Vernier Pyranometer measures the power of electromagnetic radiation in watts per square meter. It is sensitive to the near infrared, visible, and UV ranges, where nearly all of the solar energy is concentrated. It is great for experiments with solar cells and calculating their efficiency. The sensor is weatherproof and has a dome-shaped top to allow it to work with a wide range of sun angles. The Pyranometer has a 6 m cable.

IRRADIANCE RANGE: 0 to 1100 watts/m²
ABSOLUTE ACCURACY: ±5%
COSINE RESPONSE: 45°±1%
75°±5%



Pyranometer readings on a sunny day

GREAT WAYS TO USE THIS SENSOR!

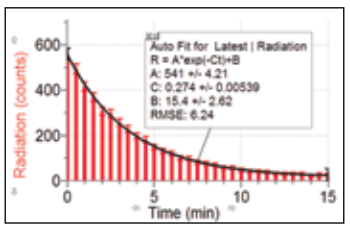
ENVIRONMENTAL SCIENCE
- Monitor the energy from the sun
- Determine the efficiency of a solar panel
- As a control in solar panel studies

Radiation Monitors

Vernier Radiation Monitor

ORDER CODE
VRM-BTD

The Vernier Radiation Monitor consists of a Geiger-Mueller tube mounted in a small, rugged, plastic case. It requires no battery, getting power from the data-collection interface. A thin window protected by a metal screen allows alpha radiation to be detected, along with beta and gamma. It can be used to explore radiation statistics, measure the rate of nuclear decay, and monitor radon progeny.



Radioactive decay

Digital Radiation Monitor

ORDER CODE
DRM-BTD

The Digital Radiation Monitor consists of a Geiger-Mueller tube and a digital rate meter mounted in a small, rugged, plastic case. The unit is battery operated and can be used with or without a computer for measurement of alpha, beta, and gamma radiation.

The Geiger-Mueller tube carries a 90-day warranty.

GREAT WAYS TO USE THESE SENSORS!

PHYSICS

NUCLEAR RADIATION
- Distance and radiation
- Lifetime measurement
- Counting statistics
- Background radiation sources

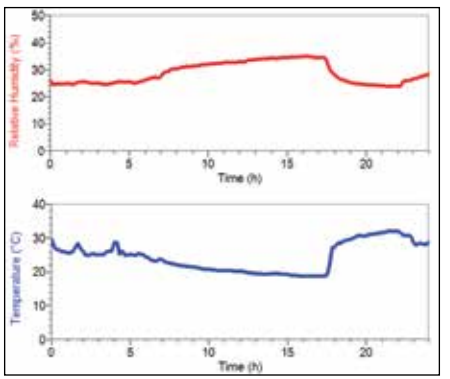
CHEMISTRY
- Alpha, beta, and gamma
- Radiation shielding
- Determining the half-life of an isotope

Relative Humidity Sensor

ORDER CODE
RH-BTA

The Relative Humidity Sensor contains an integrated circuit that can be used to monitor relative humidity over the range of 0 to 95% (±5%). Use this sensor for weather studies, monitoring greenhouses, or for determining days when static electrical discharges could be a problem.

RANGE: 0 to 95%
TYPICAL ACCURACY: ±5%



Indoor relative humidity and temperature for a 24-hour period at Vernier

GREAT WAYS TO USE THIS SENSOR!

EARTH SCIENCE
- Air temperature and relative humidity

ENVIRONMENTAL SCIENCE
- A local weather study
- Ecocolumn investigations

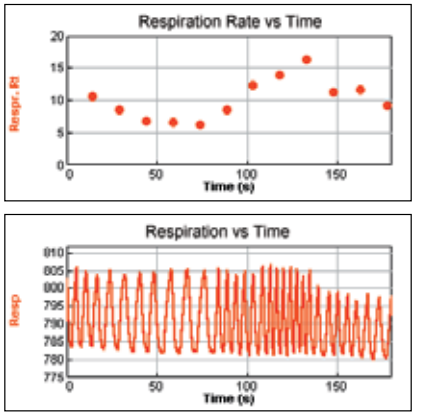
INNOVATIVE USES
- Relative humidity in caves
- Monitoring indoor relative humidity for health

Respiration Monitor Belt

ORDER CODE
RMB

(Requires GPS-BTA)

Use the Respiration Monitor Belt with our Gas Pressure Sensor (see below) to measure human respiration. Simply strap the belt around your chest and pump air into the belt with the hand bulb. Monitor the pressure associated with the expansion and contraction of your chest during breathing.



Monitoring respiration rate

Gas Pressure Sensor

ORDER CODE **GPS-BTA**

This sensor is required for use with the Respiration Monitor Belt above. Details on page 132.

GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Studying human respiration

BIOLOGY
- Control of human respiration

Rotary Motion Sensor

ORDER CODE
RMV-BTD

Monitor angular motion precisely and easily with the Rotary Motion Sensor.

- Collect angular displacement, angular velocity, and angular acceleration data
- Direction sensitive
- Measure linear position to a fraction of a millimeter

STANDARD RESOLUTION: 1.0° (angular velocity up to 30 rev/s)

HIGH RESOLUTION: 0.25° (angular velocity up to 7.5 rev/s)

Rotational Motion Accessory Kit

ORDER CODE **AK-RMV**

This accessory kit is used to study the motion of a physical pendulum; the rotational inertia of disks, rings, and point masses; and the conservation angular momentum. The kit includes

- Two 8.9 cm diameter, 0.6 cm thick solid aluminum disks
- One steel disk with 2.9 cm central hole
- One plastic hub to hold the steel disk on the 3-step pulley
- One 38 cm hollow aluminum rod
- One Ultra Pulley
- One Ultra Pulley Swivel Mount, which allows the pulley to be mounted on the Rotary Motion Sensor

For more details, visit **www.vernier.com/ak-rmv**

Rotary Motion Motor Kit

ORDER CODE **MK-RMV**

This kit includes a small electric motor with pulley, rubber band belt, motor clip, and mounting screw. The motor can be attached to the Rotary Motion Sensor, and can be used as an analog tachometer or generator. You can also perform experiments that investigate motor efficiency in different conditions. For more details, visit **www.vernier.com/mk-rmv**

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Atwood's machine experiments
- Measuring moments of inertia
- Torque experiments
- Physical pendulum
- Conservation of angular momentum

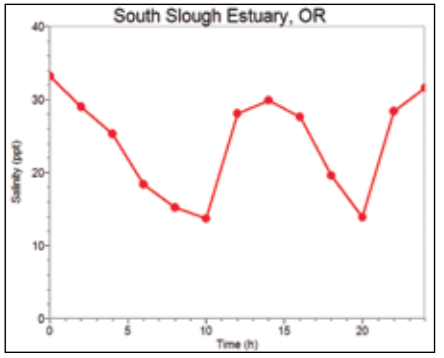
Salinity Sensor

ORDER CODE
SAL-BTA

The Salinity Sensor measures the total dissolved salt content in ocean or brackish water.

- Measure water with a wide variety of salinities, from brackish water to ocean water, and even hyper-saline environments.
- Study how salinity affects buoyancy, or monitor salinity values in estuaries where fresh water mixes with salty ocean water.

RANGE: 0 to 50 ppt



Measuring salinity in an estuary

GREAT WAYS TO USE THIS SENSOR!

ENVIRONMENTAL SCIENCE
- Studying salinity in an estuary
- Measure salinity in ocean or brackish water

INNOVATIVE USES
- GIS mapping enhances salinity
- Investigating salinity levels
- Ionic and molecular compounds
- Find the relationship between conductivity and concentration

Soil Moisture Sensor

ORDER CODE
SMS-BTA

The Soil Moisture Sensor uses capacitance to measure the water content of soil. Simply insert this rugged sensor into the soil to be tested, and the volumetric water content of soil is reported in percent. Use it to conduct experiments in ecology, environmental science, agricultural science, horticulture, biology, and more.

RANGE: 0 to 45% volumetric water content

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.1%
10-bit (CBL, CBL 2, NXT Adapter): 0.4%

Monitoring changes in soil moisture in ecocolumns

GREAT WAYS TO USE THIS SENSOR!

EARTH SCIENCE
- Measure the loss of soil moisture over time due to evaporation and plant uptake
- Evaluate optimum soil moisture contents for various species of plants
- Monitor soil moisture content to control irrigation in greenhouses

ENVIRONMENTAL SCIENCE
- Manage garden soil moisture
- Ecocolumn investigations
- Pollution study

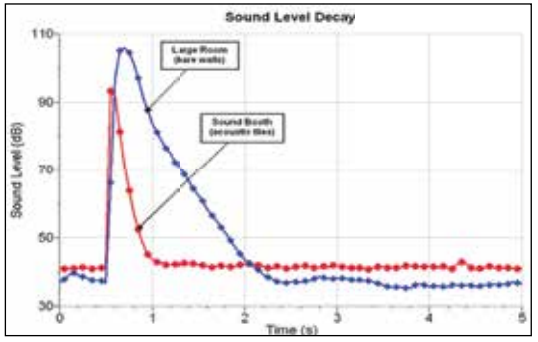
AGRICULTURAL SCIENCE
- Soil moisture

Sound Level Meter

ORDER CODE
SLM-BTA

Measure sound level in decibels (dB) with our Sound Level Meter. An output port on the meter records sound level data. A switch on the meter is used to select dBA or dBC weighting. The Sound Level Meter also has an LCD panel, which allows you to use it as a standalone device. A dB range switch and a response switch provide flexibility in standalone mode.

RANGE: 35 to 130 dB
ACCURACY: 1.5 dB at 94 dB
FREQUENCY RESPONSE: 31.5 to 8,000 Hz



Sound level decay in two rooms

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Study reverberation times
- Investigating airport noise
- Investigate room acoustics
- Measuring sound levels at a pep rally
- Investigate traffic noise
- Use for environmental noise studies

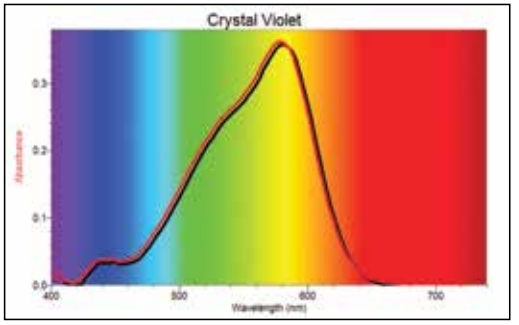
Spectrometers

SpectroVis® Plus Spectrophotometer

ORDER CODE
SVIS-PL

SpectroVis Plus is an affordable, portable, visible to near-IR spectrophotometer and fluorometer. Details on page 53.

RANGE: 380 to 900 nm
Fluorescence excitation centered at 405 nm and 500 nm
SPECIFICATIONS:
±3.0 nm wavelength accuracy at 650 nm, 1 nm reporting intervals



Absorbance spectrum of crystal violet

For more on spectrometers, see pp. 52–53.

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Beer's law
- Kinetics studies
- Determine chemical composition based on absorption spectra

ORGANIC CHEMISTRY
- Grignard formation of crystal violet
- Synthesis of fluorescein
- Synthesis of methyl orange and its application to textiles

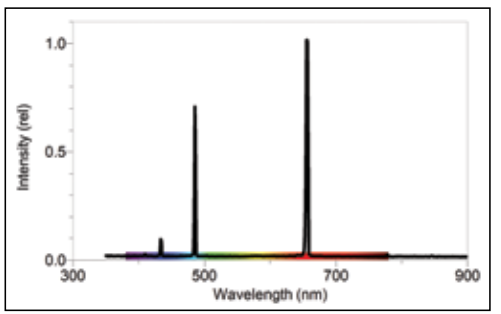
BIOLOGY
- Visible spectrum of chlorophyll
- Photosynthesis

NEW Vernier Emissions Spectrometer

ORDER CODE
VSP-EM

The perfect tool to conduct emissions analysis. The Vernier Emissions Spectrometer allows you to instantly collect emissions spectra from light bulbs, gas discharge tubes, or the sun. It connects directly to your computer or LabQuest with a standard USB cable and gives precise measurements over a range of 350–900 nm. Use the Vernier Emissions Spectrometer with or without an optical fiber.

RANGE: 350 to 900 nm
SPECIFICATIONS:
±1.0 nm wavelength accuracy, 1 nm reporting intervals



Hydrogen discharge tube emission spectrum

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Emission spectra of gases
- Emission spectra of lamps
- Reflectance spectra

CHEMISTRY
- Calculate the Rydberg constant
- View gas discharge spectral lines

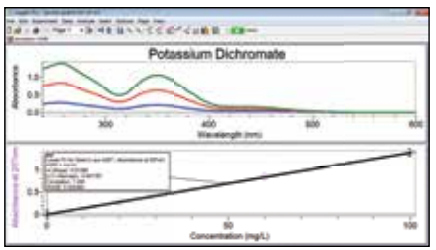
NEW Vernier UV-VIS Spectrophotometer

ORDER CODE
VSP-UV

The Vernier UV-VIS Spectrophotometer is a portable ultraviolet and visible light spectrophotometer appropriate for advanced high school, college, or graduate level education. It is an easy and accurate instrument ideal for measuring the absorbance spectra of various chemical and biochemical compounds. As a USB device, it plugs directly into your computer or LabQuest.

POWER SUPPLY: AC adapter (included)
LIGHT SOURCE: deuterium (UV) and incandescent (VIS)
DETECTOR: Linear CCD
WAVELENGTH RANGE: 220 to 850 nm
WAVELENGTH REPORTING INTERVAL: ~ 1 nm
WAVELENGTH ACCURACY*: ± 2.0 nm

*as determined with holmium oxide NIST standard



Absorbance spectrum of potassium dichromate

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Beer's law
- Kinetics studies
- Determine chemical composition based on absorption spectra

ORGANIC CHEMISTRY
- Grignard formation of crystal violet
- Synthesis of fluorescein
- Synthesis of methyl orange and its application to textiles

BIOLOGY
- Visible spectrum of chlorophyll
- Photosynthesis

Spirometer and Replacement Parts

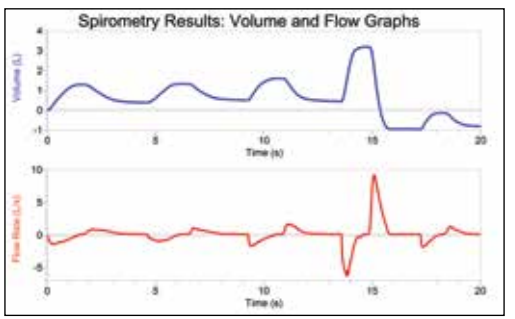
Spirometer

ORDER CODE
SPR-BTA

Use the Spirometer to perform a variety of tests related to air flow and lung volume.

- Designed to measure human respiration at rest and during moderate activity.
- Includes a removable flow head (22 mm ID/30 mm OD) for easy cleaning and sterilization, in addition to 5 disposable mouthpieces, 1 disposable bacterial filter, and 2 nose clips.

FLOW RANGE: ±600 L/min **DEAD SPACE:** 93 mL



Measuring lung volume

GREAT WAYS TO USE THIS SENSOR!

HUMAN PHYSIOLOGY
- Lung volumes and capacities
- Respiratory response to physiologic challenges
- Analysis of lung function
- Oxygen and aerobic metabolism

Disposable Bacterial Filter
(pkg. of 10)
ORDER CODE **SPR-FIL**

Use of the disposable microbacterial filter significantly reduces how often you will need to sterilize your spirometer's flow head. The filter's 30 mm ID opening allows for an easy, air-tight fit to the flow head.

Disposable Mouthpiece
(pkg. of 30)
ORDER CODE **SPR-MP**

For a more sterile environment, use the cardboard mouthpieces to help eliminate the spreading of contagious material between students.

Noseclip *(pkg. of 10)*
ORDER CODE **SPR-NOSE**

These plastic, foam-padded noseclips help increase the precision of your spirometry results by eliminating the escape of air through the nostrils during testing.

Extra Spirometer Flow Head
ORDER CODE **SPR-FLOW**

An extra flow head eliminates equipment downtime while sterilizing your original flow head. The flow head consists of a polycarbonate outer body with a stainless steel inner mesh.

O_2 Gas Sensor to Spirometer Adapter
ORDER CODE **O2-SPR**

This adapter facilitates the connection between an Oxygen Gas Sensor and a Spirometer when measuring the oxygen gas concentration and flow rate of exhaled air.

Temperature Probes

Stainless Steel Temperature Probe

ORDER CODE
TMP-BTA

This rugged and durable temperature probe has a sealed stainless steel shaft and tip that can be used in organic liquids, salt solutions, acids, and bases.

RANGE: -40 to 135°C

Extra-Long Temperature Probe

ORDER CODE
TPL-BTA

This probe has a 30-meter (100 ft) cable. It is designed for remote, outdoor temperature sensing or for measuring temperature at various depths in lakes and streams.

RANGE: -50 to +150°C

Go! Temp USB Temperature Probe

ORDER CODE
GO-TEMP

See page 21 for details.

GREAT WAYS TO USE THESE SENSORS!

CHEMISTRY
- Endothermic and exothermic reactions
- Freezing and melting of water
- Heat of fusion of ice
- Evaporation and intermolecular attractions

MIDDLE SCHOOL
- Heating of land and water
- The greenhouse effect

PHYSICS
- Newton's law of cooling

BIOLOGY
- Energy in food
- Biodiversity and ecosystems
- Aerobic respiration

PHYSICAL SCIENCE
- Boiling temperature of water
- Freezing temperature of water
- Insulation

NEW Go Wireless Temp

ORDER CODE
GW-TEMP

The Vernier Go Wireless Temp is a rugged, general-purpose, wireless temperature sensor you can use to remotely monitor temperature. Great for use with iPad!

USB charging cable is included. Free Go Wireless app is available on the App Store.

Go Wireless Temp is also compatible with Graphical Analysis for iPad (separate purchase required). See page 5.

RANGE: –40 to 125°C
RESOLUTION: 0.07°C

Measuring the temperature of ice water

GREAT WAYS TO USE THESE SENSORS!

INNOVATIVE USES
- Science fair projects
- Monitor the temperature in your fish tank or greenhouse
- Measure the efficiency of a Thermos™
- Monitor environmental conditions
- Monitor the soil temperature of your outside plants
- Measure the temperature of the air coming from your air conditioner or furnace

Surface Temperature Sensor

ORDER CODE
STS-BTA

Featuring an exposed thermistor that results in an extremely rapid response time, the Surface Temperature Sensor is ideal for situations in which low thermal mass or flexibility is required, or for a skin temperature measurement. This design allows for use in air and water.

RANGE: -25 to 125°C

Infrared Thermometer

ORDER CODE
IRT-BTA

The Infrared Thermometer is a non-contact, fast-responding temperature measuring device. The sensor works by measuring the infrared radiation emitted by objects. You simply point the sensor at the object and read its temperature.

RANGE: -20 to 400°C
ACCURACY: ±3% of reading or ±3°C, whichever is greater at 18 to 28°C ambient operating temperature
EMISSIVITY: preset 0.95

GREAT WAYS TO USE THESE SENSORS!

CHEMISTRY
- Endothermic and exothermic reactions
- Freezing and melting of water
- Heat of fusion of ice
- Pressure-temperature relationship in gases
- Evaporation and intermolecular attractions

INFRARED THERMOMETER SENSOR

INNOVATIVE USES
- Measure the temperature of hard-to-reach objects
- Investigate skin temperature
- Compare the temperature of your palm, forearm, or foot
- Compare the temperature of cars parked in the sun

Wide-Range Temperature Probe

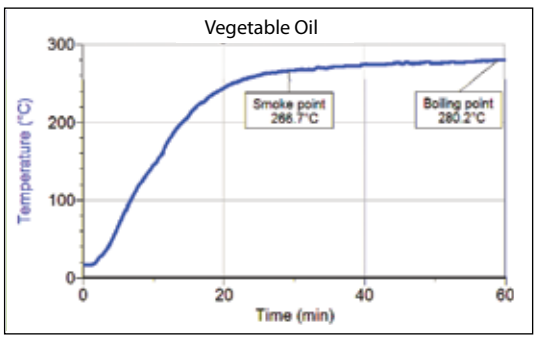
ORDER CODE
WRT-BTA

This temperature probe features a temperature range of -20°C to 330°C, which allows for melting point determinations of most organic compounds.

- Sealed, stainless-steel shaft can be used in organic liquids, salt solutions, acids, and bases.
- Long enough to extend into flasks and other common glassware.
- Diameter allows it to fit snugly in openings designed for thermometers.

RANGE SETTINGS: -20 to 330°C

ACCURACY: ±0.1°C throughout the temperature range



Temperature of warming vegetable oil using a Wide-Range Temperature Probe

GREAT WAYS TO USE THIS SENSOR!

CHEMISTRY
- Fractional distillation
- Melting temperature of organic compounds
- Determining enthalpy of a chemical reaction
- Synthesis and analysis of aspirin

ORGANIC CHEMISTRY
- Determination of a boiling point
- The Diels-Alder reaction
- Fractional distillation of esters
- Isolation and epoxidation of a natural product
- Friedel-Crafts acylation of ferrocene
- Synthesis of fluorescein

Thermocouple

ORDER CODE
TCA-BTA

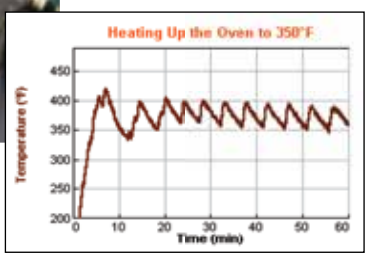
The Thermocouple uses type-K thermocouple wire to measure temperatures between -200˚C and 1400˚C.

- Measure liquid nitrogen temperatures at -196˚C and flame temperatures up to 1400˚C.
- Internal ice-point compensation means you do not need to place a reference wire in an ice-water bath.
- Individually calibrated.

RANGE:
-200 to 1400°C

TYPICAL ACCURACY:
0 to 900°C: ±2°C
–200 to 0°C: ±5°C
900 to 1400°C: ±15°C

Taking temperature of an open flame



Temperature cycles of an oven using a Thermocouple

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES
- Compare the temperature at different parts of a flame
- Compare the temperature of different flames
- Temperature cycles of an oven
- Monitor temperature of liquid nitrogen or dry ice
- Determine the melting point of copper or other solids

Turbidity Sensor

ORDER CODE
TRB-BTA

Use the Turbidity Sensor to measure the turbidity of freshwater or seawater samples.

- Small, sleek design and simple setup make it easy to use at the collection site or in the classroom.
- Monitor precipitate formation or algae and yeast populations in chemistry and biology classes.
- Includes high-quality Hach StablCal™ 100 NTU standard for quick calibration and a high-grade glass cuvette for your water sample. A set of six additional glass Turbidity Bottles are available (ORDER CODE TRB-BOT).

RANGE: 0 to 200 NTU

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.25 NTU
10-bit (CBL, CBL 2, NXT Adapter): 1.0 NTU

Measuring turbidity of a stream sample

GREAT WAYS TO USE THIS SENSOR!

WATER QUALITY
- Monitor water clarity

ENVIRONMENTAL SCIENCE
- Long-term water monitoring
- Pollution study

EARTH SCIENCE
- Water quality: turbidity
- Water treatment

UVA and UVB Sensors

ORDER CODE
UVA-BTA

ORDER CODE
UVB-BTA

We have two different sensors for measuring the intensity of ultraviolet radiation. One responds primarily to UVA radiation (320 to 375 nm), and another responds primarily to UVB radiation (290 to 320 nm). UVB radiation is commonly associated with sunburns, cataracts, and skin cancer. UVA radiation, while responsible for suntans, is also a cause of premature aging of the skin and some types of skin cancer. Which sensor you use will depend upon the particular experiment you want to perform.

UVA SENSOR
Great for use with UV lamps.

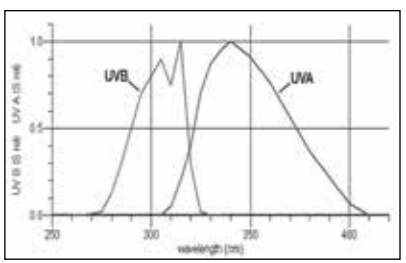
RANGE: 0 to 18,000 mW/m²
Wavelength sensitivity region approximately 320 to 375 nm
UV peak sensitivity: at 340 nm

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 5 mW/m²
10-bit (CBL, CBL 2, NXT Adapter): 20 mW/m²

UVB SENSOR
Great for use in the sun.
Recommended for our lab books.

RANGE: 0 to 900 mW/m²
Wavelength sensitivity region approximately 290 to 320 nm
UV peak sensitivity: at 315 nm

RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 0.25 mW/m²
10-bit (CBL, CBL 2, NXT Adapter): 1 mW/m²



Spectral response of the UV Sensors

GREAT WAYS TO USE THESE SENSORS!

EARTH SCIENCE
- Compare absorption in glasses
- Comparing sunscreens
- UV light and clothing

ENVIRONMENTAL SCIENCE
- Collect local weather data
- UV investigations

Voltage Probes

Differential Voltage Probe

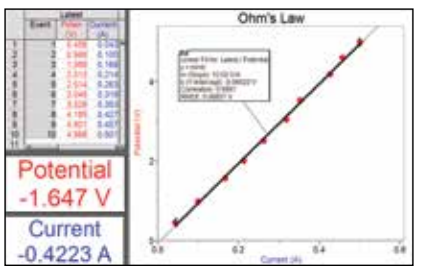
ORDER CODE
DVP-BTA

The Differential Voltage Probe is designed for exploring basic principles of electricity, including series and parallel circuits.

- Ideal for use in most battery and bulb circuits.
- Can be used to study low-voltage AC and DC circuits.
- Combine with a Current Probe to explore Ohm's law, phase relationships, and much more.

This sensor differs from our Voltage Probe (see next column) in that neither of the clips are grounded, making it possible to use two probes in the same circuit simultaneously.

RANGE: -6.0 to +6.0 V **INPUT IMPEDANCE:** 10 MΩ
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro, Go!Link): 3.1 mV
10-bit (CBL, CBL 2, NXT Adapter): 12.5 mV



Logger Pro graph showing Ohm's law using the Current Probe, Differential Voltage Probe, and the Vernier Circuit Board

GREAT WAYS TO USE THIS SENSOR!

PHYSICS
- Ohm's law
- Series and parallel circuits
- Electrical energy
- Capacitors

PHYSICAL SCIENCE
- Battery and bulb investigations

INNOVATIVE USE
- For laboratory voltage measurement

Voltage Probe

ORDER CODE
VP-BTA

This Voltage Probe can be used to measure the potential in direct-current or alternating-current circuits. In chemistry, physical science, or middle school science classes, the Voltage Probe can be used to measure voltages developed in a variety of electrochemical (voltaic) cells.

RANGE: -10 to +10 V
RESOLUTION:
12-bit (LabQuest, LabQuest Mini, LabPro): 0.005 V (5 mV)
10-bit (CBL, CBL 2): 0.020 V (20 mV)

30-Volt Voltage Probe

ORDER CODE
30V-BTA

This sensor is used to measure voltages in the range of -30 to +30 volts. Use this sensor in experiments that involve voltages larger than 10 volts, such as when working with large solar panels. Since this voltage probe covers such a wide voltage range, its resolution is lower than our Differential Voltage Probe, which we recommend for most experiments.

RANGE: -30 to +30 V

GREAT WAYS TO USE THESE SENSORS!

VOLTAGE PROBE

CHEMISTRY
- Establishing a table of reduction potentials: micro-voltaic cell
- Lead storage batteries

PHYSICS
- Capacitor charging

MIDDLE SCHOOL
- Fruit and metal voltaic cells

30-VOLT VOLTAGE PROBE

INNOVATIVE USES
- Measure output from large solar panels
- Measure voltage in do-it-yourself projects
- Measure the output from KidWind turbines

Watts Up Pro

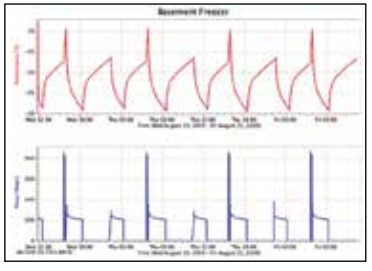
ORDER CODE
WU-PRO

Watts Up Pro measures real-time energy use of common electrical devices. Find out which costs more: running a hairdryer for 10 minutes or leaving on a lamp all afternoon? Measures potential, current, power, and cumulative cost.

- Connects to the USB port on your computer or LabQuest—no other devices needed.
- Use at the same time as a LabQuest, LabQuest Mini, LabPro, or Go!Link to monitor electricity usage in combination with other data, such as temperature, light, and relative humidity.
- The LCD panel on Watts Up Pro allows it to be used as a standalone device.

The Watts Up Pro carries a one-year warranty.

VOLTAGE: 120 V
MINIMUM MEASURABLE POWER: 0.5 watts
ACCURACY: ±1.5%, + 3 counts of the displayed value



Measuring temperature and power consumption in a basement freezer

GREAT WAYS TO USE THIS SENSOR!

INNOVATIVE USES

- Long-term monitoring of devices
- How can I save money?
- Investigate phantom load
- Compare energy use of different types of light bulbs
- Study energy use of different devices
- Analyze energy use of different wattage light bulbs
- Study energy use in charging electric cars

Wireless Dynamics Sensor System (WDSS)

ORDER CODE
WDSS

The WDSS combines a 3-axis accelerometer, force sensor, and altimeter into one unit that communicates wirelessly with your computer via Bluetooth®.

- Use it with your Bluetooth-enabled computer and Logger *Pro* to collect data free of friction due to cables.
- Internal data storage capacity allows you to use it as a standalone data logger. Great for roller coaster physics.

(Requires LabQuest 2 or a Bluetooth-enabled computer and Logger Pro *software. Can also be used with an original LabQuest with a Bluetooth dongle. See below.)*

INTERNAL DATA STORAGE CAPACITY: 240,000 points
MAXIMUM SAMPLING RATE: 1000 samples/s

FORCE	**RANGE:** ±50 N **RESOLUTION:** 0.006 N (<10 N) 0.03 N (>10 N)
ACCELEROMETERS *(for each axis)*	**RANGE:** ±50 m/s² (±5 g) **RESOLUTION:** 0.04 m/s²
ALTIMETER	**ALTITUDE CHANGE RANGE:** ±200 m **RESOLUTION:** 1 m

Bluetooth USB Dongle Radio

ORDER CODE **BLUE-USB**

Each computer or original LabQuest used with a WDSS must have a Bluetooth radio. (Note: LabQuest 2 has a built-in Bluetooth radio.) This convenient USB dongle adds Bluetooth capabilities to any Windows XP SP2, Vista, or Mac OS X 10.3 or newer computer that lacks Bluetooth.

GREAT WAYS TO USE THIS SENSOR!

PHYSICS

- Roller coaster accelerations
- Skateboarding
- Newton's second law
- Newton's third law
- Centripetal acceleration on a turntable or a merry-go-round
- Force and acceleration in simple harmonic motion

Newton's Second Law with the LabQuest 2 and the Wireless Dynamics Sensor System, showing how force and acceleration are proportional

Newton's Second Law with the Wireless Dynamics Sensor System, showing how force and acceleration are proportional

Collecting wind power data from a KidWind wind turbine

Building a robot that searches for magnets from STEM 2 with Vernier and LEGO MINDSTORMS NXT *lab book*

Do You Have Older Sensors?

ADAPTERS FOR OLDER VERNIER SENSORS	
SENSOR	**ADAPTER/CABLE**
Analog "-DIN" Sensor	DIN-BTA
Motion Detector *(with removable cable)*	MDC-BTD *(cable)*
ULI Motion Detector *(older, non-removable cable)*	CBL-RJ11
Radiation Monitor *(older model)*	RAD-BTD *(cable)*
Rotary Motion Sensor *(older model)*	ROT-BTD
Vernier Photogate *(with removable cable)*	PG-BTD *(cable)*

DIN-to-BTA Adapter
ORDER CODE **DIN-BTA**

BTA-to-DIN Adapter
ORDER CODE **BTA-DIN**

DIN-to-BTA Adapter

Our older analog sensors have a round "DIN" 5-pin plug. Our new sensors have a "BT" (British Telecom) connector. Do you have an older-style DIN sensor with a round 5-pin plug that you want to plug into a LabQuest, LabQuest Mini, LabPro, Go!Link, or CBL 2? You need a DIN-to-BTA adapter (pictured here). The sensor will not auto ID, but it will work just fine.

CABLES / ADAPTERS / POWER SUPPLIES	
PART NAME	**CODE**
AC Adapter *(for LabQuest or LabQuest Mini)*	LQ-PS
AC Adapter *(for LabPro, CBL 2, or CBL)*	IPS
Analog Sensor Extension Cable *(2 m)*	EXT-BTA
Digital Sensor Extension Cable *(2 m)*	EXT-BTD
Analog Protoboard Connector	BTA-ELV
Digital Protoboard Connector	BTD-ELV
Calculator-to-Calculator Link Cable	TI-CLC
Short Calculator Link Cable	TI-SLC
Go!Motion to Computer Cable	GMC-USB
LabPro→USB Cable *(Mac or PC)*	CB-USB
Analog Bare Wire Cable	CB-BTA
Digital Bare Wire Cable	CB-BTD
Mini-to-Standard USB Adapter	MINI-USB
Motion Detector Cable *(LabQuest, LabPro or CBL)*	MDC-BTD
Standard-to-Mini USB Adapter	USB-MINI

MORE ONLINE – Can't find the adapter you need? Check our complete list of adapters (including pictures) at **www.vernier.com/adapters**

Partners

GLOBE

BIO-RAD

OHAUS

BODELIN

FLINN
Flinn Scientific

NATIONAL INSTRUMENTS

ward's science

Independence Science

LEGO education

TEXAS INSTRUMENTS

Kid Wind PROJECT

NATIONAL MATH + SCIENCE INITIATIVE

Ocean Optics

PROJECT LEAD THE WAY PLTW

"With Vernier, every telephone call—from ordering, asking a question or having a sensor issue to solve—is handled capably and professionally with friendliness and good humor."

Cathy Theisen, Richfield High School, Richfield, MN

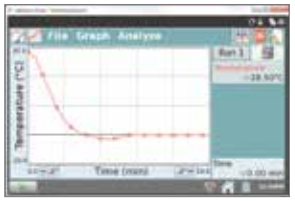
SENSOR ACCESSORIES AND REPLACEMENT PARTS

PART NAME	CODE
Blood Pressure Sensor	
Small Blood Pressure Cuff	CUFF-SM
Large Blood Pressure Cuff	CUFF-LG
Bottles	
Nalgene Bottle *(250 mL)*	CO2-BTL
Primary Productivity Kit	PPK
Turbidity Bottles *(pkg. of 6)*	TRB-BOT
Water Quality Bottles *(pkg. of 8)*	WQ-BOT
Charge Sensor	
Electrostatics Kit	ESK-CRG
High Voltage Electrostatics Kit	HVEK-CRG
CO_2 and/or O_2 Gas Sensor	
BioChamber 250 *(250 mL) (2 openings)*	BC-250
BioChamber 2000 *(2000 mL) (2 openings)*	BC-2000
Grommets for CO_2 and O_2 *(pkg. of 10)*	CO2-GROM
Respiration Chamber *(250 mL) (1 opening)*	CO2-BTL
Colorimeter/Spectrometer	
Colorimeter/Spectrometer Cuvettes *(pkg. of 100)*	CUV
Cuvette Rack	CUV-RACK
Quartz Cuvettes *(pkg. of 2)*	CUV-QUARTZ
Conductivity Probe	
Conductivity Low Standard *(500 mL)*	CON-LST
Conductivity Medium Standard *(500 mL)*	CON-MST
Conductivity High Standard *(500 mL)*	CON-HST
Dissolved Oxygen Probe (Original)	
DO Calibration Solution *(60 mL)*	DO-CAL
DO Filling Solution *(130 mL)*	FS
DO Polishing Strips	PS
DO Probe Membrane Cap	MEM
Dissolved Oxygen Probe (Optical)	
Optical DO Probe Replacement Cap	ODO-CAP
Optical DO Probe Metal Guard	ODO-GRD
EKG Sensor	
EKG Electrodes	ELEC
Ethanol Sensor	
Ethanol Cap Assemblies *(pkg. of 3)*	ETH-CAPS
Ethanol Stopper	ETH-STOP
Ethanol Tape	ETH-TAPE
Gas Pressure Sensor	
Pressure Sensor Accessories Kit	PS-ACC
#1 1-Hole Rubber Stopper	PS-STOP1

PART NAME	CODE
Gas Pressure Sensor (continued)	
#5 2-Hole Rubber Stopper	PS-STOP5
Luer Lock Connector	PS-LUER
Plastic 2-Way Valve	PS-2WAY
Plastic Tubing	PS-TUBING
Plastic Tubing Clamps *(pkg. of 100)*	PTC
Stopper Stem	PS-STEM
Syringe (20 mL, plastic)	PS-SYR
Ion-Selective Electrodes	
ISE Ammonium Replacement Module*	NH4-MOD
ISE Calcium Replacement Module*	CA-MOD
ISE Nitrate Replacement Module*	NO3-MOD
ISE Potassium Replacement Module*	K-MOD
ISE Ammonium Low Standard *(500 mL)*	NH4-LST
ISE Ammonium High Standard *(500 mL)*	NH4-HST
ISE Calcium Low Standard *(500 mL)*	CA-LST
ISE Calcium High Standard *(500 mL)*	CA-HST
ISE Chloride Low Standard *(500 mL)*	CL-LST
ISE Chloride High Standard *(500 mL)*	CL-HST
ISE Nitrate Low Standard *(500 mL)*	NO3-LST
ISE Nitrate High Standard *(500 mL)*	NO3-HST
ISE Potassium Low Standard *(500 mL)*	K-LST
ISE Potassium High Standard *(500 mL)*	K-HST
Melt Station	
Melt Station Capillary Tubes *(pkg. of 100)*	MLT-TUBE
Mini GC/Mini GC Plus	
GC Septa *(pkg. of 4)*	GC-SEP
GC Syringe, 1 µL Hamilton	GC-SYR-MIC
Motion Detector	
Motion Detector Clamp	MD-CLAMP
Optics	
Color Mixer Kit	CM-OEK
Diffraction Apparatus	DAK
Mirror Set	M-OEK
Optics Expansion Kit	OEK
Polarizer/Analyzer Kit	PAK-OEK
pH Sensor	
Microstirrer	MSTIR
pH Buffer Capsules	PHB
BNC pH Electrode *(for EA-BTA; with BNC connector)*	7120B
pH Storage Bottles *(pkg. of 5)*	BTL

PART NAME	CODE
pH Sensor (continued)	
pH Storage Solution *(500 mL)*	PH-SS
Photogate	
Cart Picket Fence	PF-CART
Laser Pointer	LASER
Laser Pointer Stand	STAND
Photogate Bar Tape Kit	TAPE-VPG
Picket Fence	PF
Pulley Bracket	B-SPA
Ultra Pulley Attachment	SPA
Polarimeter (Chemical)	
Polarimeter Sample Cells *(pkg. of 4)*	CELLS-POL
Power Amplifier	
Accessory Speaker	PAAS-PAMP
Rotary Motion	
Rotary Motion Accessory Kit	AK-RMV
Rotary Motion Motor Kit	MK-RMV
Centripetal Force Apparatus	CFA
Salinity Sensor	
Salinity Standard *(35 ppt salinity, 500 mL)*	SAL-ST
Spirometer	
Disposable Bacterial Filter *(pkg. of 10)*	SPR-FIL
Disposable Mouthpiece *(pkg. of 30)*	SPR-MP
Noseclip *(pkg. of 10)*	SPR-NOSE
Spirometer Flow Head	SPR-FLOW
O_2 Gas Sensor to Spirometer Adapter	O2-SPR
Turbidity Sensor	
Turbidity Bottles *(pkg. of 6)*	TRB-BOT
Turbidity Cuvette and Standard	TRB-ACC
Vernier Dynamics System	
Bumper and Launcher Kit	BLK
Cart Fan	FAN-VDS
Friction Pad	PAD-VDS
Vernier Projectile Launcher	
Independence of Motion Accessory	IOM-VPL
Projectile Stop	PS-VPL
Time of Flight Pad	TOF-VPL
Wireless Dynamics Sensor System Accessories	
Bluetooth USB Dongle Radio	BLUE-USB

*ISE modules have a life expectancy of 1–2 years. We recommend that you do not purchase ISE replacement modules too far in advance of their expected time of use; degradation occurs while replacement modules are stored on the shelf.



a

b

c

d

a. LabQuest Viewer,
ORDER CODE **LQ-VIEW**

LabQuest Viewer (electronic download),
ORDER CODE **LQ-VIEW-E**

Use this software to teach students how to use LabQuest by projecting your LabQuest screen via Wi-Fi. Use built-in Wi-Fi on LabQuest 2 to remotely monitor student progress by viewing student LabQuests. Compatible with both Mac and PC.

Computer software includes a site license for every teacher's computer in your school or college department.

LabQuest Viewer is also available for iPad. See page 26.

Watch for new features coming in spring 2014—free upgrade!

b. LabQuest 2 Lab Armor
ORDER CODE **LQ2-ARMOR**

Add extra protection from spills and falls with Lab Armor for LabQuest 2. Molded rubber material helps prevent spills from getting into open ports.

c. LabQuest 2 Charging Station
ORDER CODE **LQ2-CRG**

Original LabQuest Charging Station
ORDER CODE **LQ-CRG**

Multi-bay charging capability for your original LabQuest or LabQuest 2. Each charging station has four charging slots.

d. LabQuest Battery Boost 2
ORDER CODE **LQ-BOOST2**

The Battery Boost 2 is a rechargeable external battery for your original LabQuest or LabQuest 2. Collect data for extended periods where AC power is not available.

LabQuest Accessories

LABQUEST 2
ACCESSORIES / REPLACEMENT PARTS

PART NAME	CODE
LabQuest 2 Charging Station	LQ2-CRG
LabQuest 2 Lab Armor	LQ2-ARMOR
LabQuest 2 Stand	LQ2-STN
LabQuest Computer Cable	LQ-CB-USB
LabQuest Power Supply	LQ-PS
LabQuest Tether *(pkg. of 5)*	LQ-TETH-5
LabQuest Lanyard	LQ-LAN
LabQuest 2 Battery	LQ2-BAT
LabQuest Battery Boost 2	LQ-BOOST2
LabQuest 4GB SD Card	LQ-SD4
LabQuest 2 Stylus *(pkg. of 5)*	LQ2-STYL-5
LabQuest International Power Supply	LQ-PS-INTL

ORIGINAL LABQUEST
ACCESSORIES / REPLACEMENT PARTS

PART NAME	CODE
LabQuest Charging Station	LQ-CRG
LabQuest Computer Cable	LQ-CB-USB
LabQuest Power Supply	LQ-PS
LabQuest Tether *(pkg. of 5)*	LQ-TETH-5
LabQuest Lanyard	LQ-LAN
LabQuest Battery	LQ-BAT
LabQuest Battery Boost 2	LQ-BOOST2
LabQuest 4GB SD Card	LQ-SD4
LabQuest Stand	LQ-STN
LabQuest Stylus *(pkg. of 5)*	LQ-STYL-5
LabQuest International Power Supply	LQ-PS-INTL
LabQuest Wi-Fi USB Adapter	WIFI-USB
Vernier GPS Sensor	VGPS

PROFESSIONAL DEVELOPMENT

About Our Trainers

Vernier's Professional Training Staff includes

- 38 current or former classroom science and math teachers, all of whom have used Vernier equipment and software in their own classes
- Teachers who, as a group, possess a total of 940 years of teaching experience, encompassing all subject areas and grade levels
- Educators with prestigious teaching awards in their respective states and teaching subject areas, including 6 Presidential Awardees, one Woodrow Wilson Dreyfus Master Teacher, 3 Tandy Technology Scholars, one Radio Shack Technology Awardee, one DaVinci Science Center Hall of Fame Master Teacher, 2 GTE Gift Awardees, one Excellence in Pre-College Physics Teaching Awardee, and a variety of science educator of the year recipients, as well as many other awards
- Authors of more than 60 science books and lab manuals (including many of our own Vernier lab books)

IMPROVING TEACHER EFFECTIVENESS

Data-collection training gives teachers the skills to teach with the latest in sensor technology. All teachers will conclude their Vernier training with a certificate of completion indicating the number of hours spent in training. For more information on probeware and student achievement, see page 157.

Graduate Education Credit Available

NEED TO EARN CREDIT?

Attend one of our workshops that is four hours or longer and you will have the opportunity to earn two (quarter) Graduate Science credit hours through the Portland State University Center for Science Education. For more details on this professional development option, see **www.vernier.com/gradcred**

Many states offer Continuing Education Credit or clock hours for attendance at workshops held at professional conventions or at in-service training. We are happy to provide documentation of your attendance at any of our hands-on or demonstration workshops, hundreds of which are offered throughout the country each year. For more details, contact us at **pd@vernier.com**

FREE Hands-On, Data-Collection Workshops

LabQuest 2 | Computer Data Collection

4 HOUR

Calling all science educators! Step out of your classrooms, roll up your sleeves, and join us in the Vernier laboratory for a four-hour exploration of the latest and greatest in probeware and data-collection technology. Learn how to integrate our technology into your chemistry, biology, physics, middle school science, physical science, and Earth science curriculum. Contact us or visit our web site for up-to-date information and registration.

Perfect for science educators interested in

- Evaluating our award-winning, data-collection technology
- Getting started with probeware and data collection
- Refreshing their knowledge of Vernier equipment
- Learning from experts

Attendees receive

- Four hours of free training
- Light lunch or dinner
- Workshop Training Manual on CD
- Discount on LabQuest 2 Training Package or LabQuest Mini Training Package

2014 HANDS-ON DATA-COLLECTION WORKSHOPS

SPRING WORKSHOPS		FALL WORKSHOPS	
Alabama	Birmingham	**Illinois**	Chicago
Arizona	Phoenix	**Indiana**	Evansville, Indianapolis
Arkansas	Little Rock	**Kansas**	Topeka, Wichita
California	Irvine, Oakland, San Bernardino, San Jose	**Kentucky**	Lexington, Louisville
Colorado	Colorado Springs, Denver, Fort Collins	**Massachusetts**	Boston
Connecticut	Hartford	**Michigan**	Detroit
Delaware	Wilmington	**Minnesota**	Minneapolis
Florida	Jacksonville, Miami, Orlando, Tampa	**Missouri**	Kansas City, St. Louis
Georgia	Atlanta	**Nebraska**	Lincoln
Maryland	Baltimore	**New Hampshire**	Portsmouth
Mississippi	Jackson	**New York**	Albany, Buffalo, Rochester
New Jersey	Newark, Princeton	**Ohio**	Cincinnati, Cleveland, Columbus, Toledo
New York	White Plains	**Oklahoma**	Oklahoma City, Tulsa
North Carolina	Charlotte, Raleigh/Durham, Winston-Salem	**Pennsylvania**	Pittsburgh
Pennsylvania	Philadelphia	**Rhode Island**	Providence
South Dakota	Rapid City	**South Dakota**	Sioux Falls
Tennessee	Chattanooga, Knoxville, Memphis, Nashville	**Texas**	Dallas, Houston, San Antonio
Virginia	Fairfax County	**Wisconsin**	Madison, Milwaukee

Summer Institutes: Data Collection

LabQuest 2 | Computer Data Collection

1 DAY

In this six-hour workshop, you will get hands-on experience with Vernier's award-winning line of computer and handheld data-acquisition technology. One of our knowledgeable training specialists will work right alongside you, providing guidance and inspiration as you explore classroom-ready labs.

You'll leave the workshop ready to integrate our data-collection technology into your chemistry, biology, physics, middle school science, physical science, and Earth science curriculum. The registration fee includes lunch, lab handouts on CD, and a lab manual of your choice. Please see the web site for Training Package pricing.

Register online at **www.vernier.com/summer-institutes/**

JUNE	JULY	AUGUST
San Antonio, TX	Boston, MA	Missoula, MT
Dallas, TX	Long Island, NY	Spokane, WA
Little Rock, AR	Philadelphia, PA	Beaverton, OR
Minneapolis, MN	Baltimore, MD	
Des Moines, IA	Washington DC	
Chicago, IL	Norfolk, VA	

MORE ONLINE – Information available at **www.vernier.com/training**

FREE Hands-On Training at Conferences

Vernier will offer hands-on workshops at each of these conferences. For a full listing of our conference exhibits, check our web site at **www.vernier.com/conferences**

- **Hoosier Association of Science Teachers, Inc.,** Indianapolis, IN, February 5–7
- **Wisconsin Society of Science Teachers,** Appleton, WI, March 13–15
- **NSTA National Conference,** Boston, MA, April 3–6
- **NSTA STEM Forum & Expo,** New Orleans, LA, May 14–17
- **American Association of Physics Teachers,** Minneapolis, MN, July 26–30
- **Biennial Conference on Chemical Education**, Allendale, MI, August 3–7
- **International STEM Education Association,** Branson, MO, October 12–14
- **New Jersey Science Convention,** Princeton, NJ, October 14–15
- **NSTA Area Conference,** Richmond, VA, October 16–18
- **NSTA Area Conference,** Orlando, FL, November 6–8
- **National Association of Biology Teachers,** Cleveland, OH, November 12–15
- **Conference for the Advancement of Science Teaching,** Dallas, TX, November 20–22
- **NSTA Area Conference,** Long Beach, CA, December 4–6

VERNIER WORKSHOP IN BEAVERTON

We can conduct a one-day workshop at our office specially designed for you. The workshop can be training only (no charge) or it can include equipment as part of the cost. For information, go to **www.vernier.com/workshops-at-vernier**

VERNIER WORKSHOP AT YOUR SCHOOL

We can come to your school to do a one-day, hands-on workshop using your Vernier equipment. This workshop can be computer or handheld-based data collection, in any science subject. More information and an on-site workshop application can be found on our web site at **www.vernier.com/workshops-at-school**

ADDITIONAL WORKSHOPS

For information on independent workshops that provide instruction in the use of Vernier products, go to **www.vernier.com/training/independent**

WEBINARS

Join us for a free, one-hour training online. Sessions are broadcast live on the web and recorded versions are available for download. Topics include

- LabQuest 2 and the Connected Science System
- Biotechnology: Gel Analysis
- Physics: Video Analysis
- Chemistry: pH Titration
- Chemistry: Beer's Law

For the schedule of upcoming webinars, see **www.vernier.com/webinars**

CHAUTAUQUA SHORT COURSE:

Promoting Active Learning in Introductory Physics Courses with Research-Based Curricula and Tools

This hands-on course is designed for those who teach introductory physics at universities, colleges, and high schools. Graduate credit will be available from the University of Oregon.

June 15–17, 2014
Vernier Software & Technology, Beaverton, OR

Instructors: Priscilla Laws (Dickinson College), David Sokoloff (University of Oregon), Ronald Thornton (Tufts University)

For more information and to register **http://pages.uoregon.edu/sokoloff/CHAUT.htm** or contact David Sokoloff, sokoloff@uoregon.edu, 541-346-4755

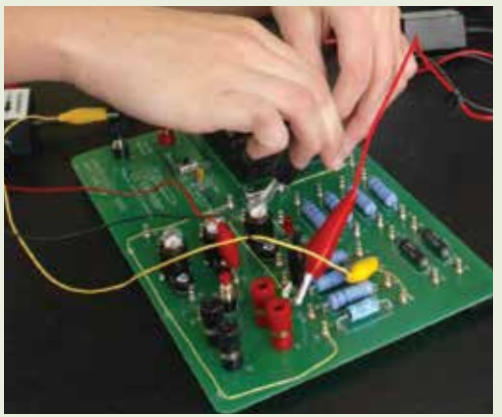
Two-Day, Subject-Specific Institutes

2 DAYS BIOLOGY/AP BIOLOGY

This 2-day, hands-on workshop gives you the opportunity to explore how to integrate probeware into your biology courses. You will have the option to conduct experiments in human physiology, ecology, and biotechnology. A variety of experiments that are correlated to the new AP Biology framework will be offered. Specific emphasis will be placed on conducting inquiry-based laboratory investigations, such as cell respiration, transpiration, and enzyme action.

Experiments and sensors include
- Grip Strength and Muscle Fatigue – Hand Dynamometer
- Cell Respiration – CO_2 Gas Sensor
- Yeast Metabolism and Evolution of Yeast – CO_2 Gas Sensor
- Testing Catalase Activity – Gas Pressure Sensor
- The Visible Spectra of Plant Pigments – SpectroVis Plus
- Primary Productivity – Optical DO Probe
- Introduction to Biofuels and Evolution of Cellobiase – SpectroVis Plus

This workshop will be held July 21–22, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a copy of the Vernier lab book, *Investigating Biology through Inquiry*. You may also be able to earn graduate or continuing education credit through Portland State University.



2 DAYS PHYSICS

This 2-day, hands-on physics workshop gives you the opportunity to explore data collection and video tools offered by Vernier. You will learn basic and advanced skills in Logger *Pro*, such as configuring graphs, performing custom curve fits, setting up calculated columns, and customizing data-collection modes. Video analysis using computers and tablets will be covered. A variety of Vernier interfaces and applications will be available, including LabQuest, LabQuest Mini, and iOS and Android apps.

Topics include
- Dynamics and kinematics using the new Motion Encoder Cart and the Vernier Dynamics System
- Optics and diffraction using the Optics Expansion Kit and the Diffraction Apparatus
- Circuits using the Vernier Circuit Board

This workshop will be held July 16–17, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a copy of *Physics with Vernier*, 2nd edition. You may also be able to earn graduate or continuing education credit through Portland State University.

2 DAYS AP CHEMISTRY

During this 2-day, hands-on workshop, you will explore how to integrate probeware into your AP Chemistry courses. You will learn how Vernier products and lab books can be used to meet requirements of the new AP Chemistry framework. A significant portion of the workshop focuses on inquiry-based methods of conducting experiments.

Examples of experiments and sensors that will be covered include
- Acid-Base Titration: Determining the K_a of a Weak Acid – pH Sensor
- Determining the Rate Law of a Chemical Reaction – SpectroVis Plus
- Identifying an Unknown Solid by Melting Temperature – Melt Station
- A Redox Titration – Oxidation-Reduction Potential (ORP) Sensor
- The Determination of an Equilibrium Constant – SpectroVis Plus
- Analyzing a Mixture with a Gas Chromatograph – Mini GC Plus

This workshop will be held July 24–25, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a copy of the Vernier lab book, *Investigating Chemistry through Inquiry*. You may also be able to earn graduate or continuing education credit through Portland State University.

One-Day, Subject-Specific Institutes

1 DAY ENVIRONMENTAL SCIENCE/ FIELD BIOLOGY

Learn how to integrate probeware into your environmental science or field biology course during this 1-day, hands-on workshop. You will have the opportunity to conduct a variety of experiments correlated to the AP Environmental Science framework. Specific emphasis will be placed on conducting inquiry-based investigations, such as "Investigating Water Quality" and "Primary Productivity." Attendees should be prepared to spend time outside collecting data.

A variety of investigations and sensors will be covered, including
- Biochemical Oxygen Demand – Optical DO Probe
- Primary Productivity – Optical DO Probe
- Investigating Water Quality – Conductivity Probe, pH Sensor, Turbidity Sensor
- Soil and Acid Rain – pH Sensor
- Microclimates – PAR Sensor, Temperature Probe, UVB Sensor

This workshop will be held July 23, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a copy of the Vernier lab book, *Investigating Environmental Science through Inquiry*. You may also be able to earn graduate or continuing education credit through Portland State University.

1 DAY ENGINEERING

Engineering and STEM with Logger *Pro*

Explore several ways to use Logger *Pro* software and Vernier technology to introduce STEM and engineering during this 1-day, hands-on workshop.

You will learn how a Digital Control Unit (DCU) can be used to develop logic-based, sensor-control systems, and how you can use Logger *Pro* software for testing as you work through revisions using the engineering design method.

Some of the exercises you will perform
- Controlling inexpensive DC devices (motors, buzzers, LEDs, and others) with the DCU
- Creating an automated, sensor-controlled apparatus
- Calibrating an analog sensor
- Building your own sensor
- Investigating student bridges

This workshop will be held July 14, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a Vernier Digital Control Unit. You may also be able to earn graduate or continuing education credit through Portland State University.

Note that the Arduino and LEGO workshops are both on the day following this workshop. Consider attending one of these if you are interested in further training on engineering education topics.

Vernier Sensors with Arduino™

The availability of inexpensive, easy-to-program microcomputers, such as Arduino, make STEM and engineering projects easy and affordable. Microcomputers are becoming a great tool for students (and teachers) to get excited about hands-on, do-it-yourself projects.

This 1-day, hands-on workshop gives you the opportunity to explore different ways to use your Vernier sensors with an Arduino microcontroller.

You will learn the fundamentals of programming the Arduino and be introduced to the sample code available on our web site.

Some of the topics that will be included
- Connecting and calibrating Vernier sensors
- Writing programs (called sketches for Arduino) to read Vernier sensors
- Logging data with Arduino and exporting data to Logger *Pro* for analysis
- Creating interactive Arduino projects

This workshop will be held July 15, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch and a Vernier Interface Shield produced by SparkFun. You may also be able to earn graduate or continuing education credit through Portland State University.

Vernier Sensors with LEGO®

LEGO robotics technology provides an engaging and popular way to introduce students to robotics, STEM, and engineering concepts.

During this 1-day, hands-on workshop, you will explore different ways to use your Vernier sensors with LEGO robotics. You will learn how to use Vernier sensors in the LEGO software development system, as well as how to create engaging projects.

Examples of topics that will be covered:
- Explore how to use Vernier sensors with LEGO robotics systems.
- Write LEGO MINDSTORMS programs to read Vernier sensors.
- Create hands-on projects that are great for getting students interested in STEM.

This workshop will be held July 15, 2014 in Beaverton, Oregon, at the Vernier office. The registration fee includes lunch, a copy of *STEM 2 with Vernier and LEGO MINDSTORMS NXT* lab book and an NXT Sensor Adapter. You may also be able to earn graduate or continuing education credit through Portland State University.

GENERAL INFO

Why Choose Vernier?

Products and service that set us apart

Developed by Teachers, for Teachers

We understand the concerns of teachers, and we work hard to make your job easier. Our product development and technical support staff have over 100 years of teaching experience. We understand your concerns because we've been there.

Versatility that Translates into Savings

Vernier gives you more freedom of choice than any other probeware company. We offer state-of-the-art technology with the Vernier LabQuest 2 and our wireless sensors. We offer a wide array of low-cost solutions with our Go! products and our LabQuest Mini. And we offer the Vernier LabPro, which can be used with computers or TI graphing calculators.

Generous Warranty that Lets You Buy with Confidence

Vernier's 5-year warranty on most products gives you a superior level of buying confidence. In fact, in Vernier's 33 years of business, we have rarely charged a customer for a repair, no matter how old the equipment!

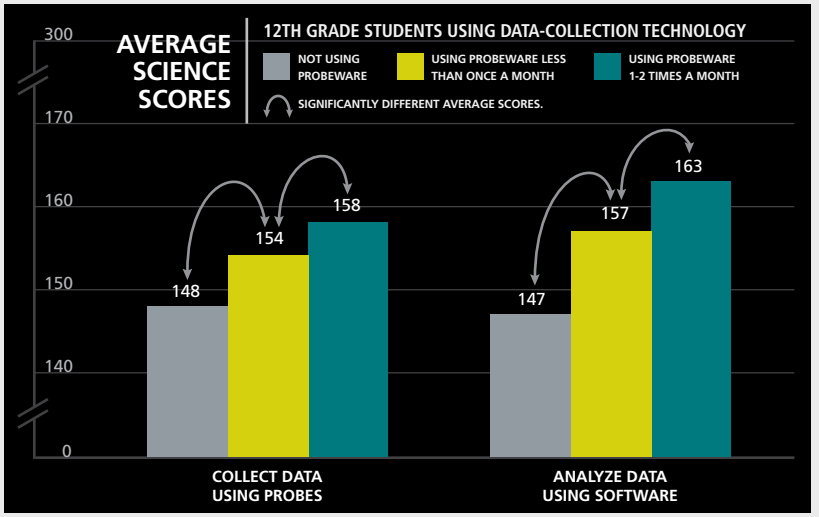
Logger *Pro* 3 Site License Offers Tremendous Value

Purchase our award-winning Logger *Pro* 3 software, and you are entitled to install the program on every computer in your school or college department AND give it to your students to use on their home computers. Excited? There's more.

Logger *Pro* 3 contains all the functions of Graphical Analysis software, including calculator-import and manual-entry data analysis features. That translates into the lowest total cost of software ownership in the education market, with access for every educator and student in your school. No other company offers such a generous site license policy. That's value!

EXTRAORDINARY CUSTOMER SERVICE AND TECHNICAL SUPPORT

When you call Vernier, you'll talk to a former teacher, a lab book author, or a technical expert. You'll speak with people who are passionate about education, science, and helping students succeed. What's the best part? You won't ever talk to sales representatives—just educators and people committed to extraordinary customer service for teachers.



Source: The 2000 NAEP Science Assessment. This study of 49,000 U.S. students shows that students who used probeware to collect and analyze data scored significantly higher on tests than those who did not.

Go to **www.vernier.com/research** for more details

New to Data Collection?

Why Should I Use Data-Collection Technology?

Data collection and analysis helps teachers increase students' critical thinking skills through hands-on learning. Students achieve higher test scores when probeware is included in engaging curricular activities.

Data-collection technology

- Use of data-collection technology is called for in the *Framework for K-12 Science Education*
- Frees class time for student engagement in higher-order thinking skills, such as analysis, synthesis, and evaluation
- Supports STEM education and priorities outlined under ARRA and Race to the Top
- Enables students to perform many new experiments with measurements not previously obtainable in the classroom
- Increases test scores in science
- Is recommended by national organizations, including NSTA, ISTE, ASTE, and IB
- Encourages inquiry-based lab activities
- Supports National Science Education Standards

Request a White Paper on Using Probeware for Science Education

Hands-on science using Vernier technology gets students excited about science and deepens their understanding of complex concepts. It gives students the tools to analyze data and think like real scientists. For more on probeware in science, request our white paper at **www.vernier.com/whitepaper**

Vernier and NGSS

The eight Science and Engineering Practices, including Planning and Carrying Out Investigations, Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking, represent the foundation of our experiments. We've always been a hands-on science company, and we encourage students to investigate natural phenomena and solve real-world problems.

When you look through our lab books, you will see that we have approached engineering both implicitly, through challenges such as "Keepin' It Cool, Design Your Own Thermos™," "Solar Homes," or "The Pencil Car," among others, and explicitly, in books such as our *STEM with Vernier and LEGO Mindstorms NXT, STEM 2 with Vernier and LEGO Mindstorms NXT, Engineering Projects with Vernier,* and the *Hands-On Introduction to NI LabVIEW with Vernier* lab books. We also have STEM extensions available on our web site that use sensor data, the Vernier Digital Control Unit, and Logger *Pro* software to create sensor-based control systems. These include "Cooling Fan," "Eye-Controlled LED," "Hand-Sensing Dryer," and others.

Visit our web site to see a graphical representation of how "Keepin' It Cool, Design Your Own Thermos™" incorporates the Performance Expectations, Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas of NGSS. **www.vernier.com/ngss**

For questions about this or other content inquiries, contact us at publications@vernier.com

Contests and Grants

ENGINEERING CONTEST

Are you using Vernier sensors to teach engineering concepts or engineering practices in the classroom? If you are, you could win one of three $5,500 awards (one for middle school, one for high school, and one for college).

Maybe your students are using Vernier sensors to test a design project. Or maybe you are challenging your students to build an automated device using the Vernier Digital Control Unit (DCU) and Logger *Pro* software. Perhaps your students are writing NI LabVIEW or ROBOTC code to read a Vernier sensor from a robotics platform such as LEGO, VEX, or Arduino. Tell us about your projects, and you might win!

Each award will consist of $1,000 in cash, $3,000 in Vernier technology, and $1,500 toward expenses to attend either the annual NSTA STEM conference or the annual ASEE conference. For complete rules and to submit an online application and video showcasing your entry, go to **www.vernier.com/grants/engineering**

VERNIER / NSTA TECHNOLOGY AWARD

Award of $5,500 in Prizes for Each Teacher

Full-time science teachers from elementary to college level are eligible to apply for the Vernier Software & Technology/NSTA Technology Award. Vernier will provide up to seven awards, each valued at $5,500, for educators who demonstrate innovative uses of data-collection technology using a computer, graphing calculator, or other handheld device in the science classroom.

The awards will be given to one elementary teacher, two middle school teachers, three high school teachers, and one college-level educator. Each will receive a $1,000 cash award, $3,000 in Vernier equipment, and $1,500 towards travel and expenses to attend NSTA's National Convention in 2015.

For guidelines, a grant application, and profiles of previous winners, go to **www.vernier.com/grants/nsta**

"Technology is needed…not just to give students exposure to the technology or to satisfy parents; technology greatly improves learning and supports science education standards that are difficult to teach without using technology."

Metcalf, S. J., & Tinker, R. 2003
TEEMSS: Technology Enhanced Elementary and Middle School Science, *Annual Meeting of the National Association for Research in Science Teaching March 23–26, 2003, Philadelphia*

NABT ECOLOGY/ENVIRONMENTAL SCIENCE TEACHING AWARD

The NABT Ecology/Environmental Science Teaching Award will be granted to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his/her commitment to the environment into the community.

Each award consists of a one-year complimentary NABT membership, award plaque, $500 in Vernier technology, and $1,000 toward expenses to attend the NABT Professional Development Conference. For complete rules and to submit an online application, go to **www.vernier.com/grants/nabt**

VERNIER GRANT WRITING GUIDE

Looking to fund a state-of-the-art science lab? Vernier has gathered a variety of tips for writing a winning grant proposal.

The Vernier Grant Writing Guide includes

- Supporting Your Vision
- Identifying Your Funding
- Writing Your Proposal
- Putting It All Together
- Supporting Your Proposal
- Following Up on Your Grant

This guide will help you write a successful grant proposal.

MORE ONLINE – Download the Vernier Grant Writing Guide at **www.vernier.com/grants**

"I love Vernier for the fact that when you call for help, you talk to real people, in real time, and you don't have to listen to a long list of menu options which may have changed."

Gary Patterson, Vincennes University, Vincennes, IN

Terms and Conditions

VERNIER SITE LICENSE

We have a very generous site license policy. The purchase of one copy of Logger *Pro*, LabQuest Viewer, or Graphical Analysis entitles you to install it on every computer in your school or, for post-secondary institutions, department. Logger Lite is available as a free download from our web site. Installation to local machines over a network is allowed. Purchasers are also permitted to distribute these programs to their students and instructors for home use. The license is limited to a single campus if your institution has multiple campuses. Site license terms do not apply to Vernier iOS software products.

OTHER SOFTWARE

NI LabVIEW for Education, Davis WeatherLink, WeatherLink IP for Vantage Pro, ProScope HR software, and software from Texas Instruments are licensed under separate agreements by their respective companies.

TECHNICAL SUPPORT

We are readily available to help you with individual questions about our software and hardware—simply email support@vernier.com or call us on our toll-free number: 888-VERNIER (888-837-6437).

We publish a periodic newsletter, *The Caliper*, with information on upgrades, suggestions for new ways to use our programs, and announcements of new products.

PREVIEW POLICY

Most Vernier products are available for a 30-day preview (or longer, if requested) to educational institutions.

SATISFACTION GUARANTEE

Any product that does not meet your needs may be returned within 30 days for a full refund, subject to the Equipment Return policy. Equipment returned after 30 days may be subject to a restocking fee.

PRODUCT USAGE

Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind. We design our products with the specifications and features that educators and students need to be successful. In our effort to keep our products affordable and easy to use, we may not meet the specifications or include the features that an industrial scientist or medical professional might want.

WARRANTIES

Most Vernier products carry a five-year limited warranty. There are a few exceptions to this warranty for items such as consumables and products manufactured by other companies. These exceptions can be found in each product's manual, our catalog, and on our web site. During the warranty, Vernier will repair or replace the item if there is a defect in materials or workmanship. This warranty does not cover damage to the product caused by abuse or improper use. Outside the warranty, Vernier will attempt to repair the product. In our 33 years, we have rarely charged a customer for repair, no matter how old the equipment!

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A Return Merchandise Authorization, available from Vernier, is required for any product return. Equipment returned for exchange or credit must be in new condition and in its original packaging. Items returned after 30 days of purchase may be subject to a restocking fee.

INTERNATIONAL SALES

Most sales of Vernier products outside the U.S. are handled by:

Vernier International
5026 Calle Minorga, Sarasota, FL 34242
Phone 941-349-1000; Fax 941-349-2766
www.vernier-intl.com | info@vernier-intl.com

Sales in Canada are handled by:

Merlan Scientific
6050 Tomken Rd., Mississauga, ON, Canada L5T 1X8
Phone 905-564-1080; Toll Free 800-387-2474
Fax 800-374-6714; **www.merlan.ca** | info@merlan.ca

PRICES AND SHIPPING

Prices are effective January 1, 2014 and supersede previously published prices. Prices are in U.S. dollars and are F.O.B. Shipping Point. Shipping charges may vary, depending on method of shipment. Prices are subject to change without notice.

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If you wish to be removed from our mailing list, simply write to us at info@vernier.com, and we will remove you immediately.

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Logger *Pro*, LabQuest, LabPro, SpectroVis, SensorDAQ, Vernier and caliper design, Go!, Go!Link, Go!Temp, Go!Motion, Logger Lite, Connected Science System, LabQuest Viewer, Vernier EasyLink, Vernier EasyTemp, and Vernier EasyData are our registered trademarks. Vernier Software & Technology, vernier.com, BlueView, Go Wireless, and Graphical Analysis are our trademarks or trade dress.

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Vernier has been selling science software and data-collection hardware since 1981. We pride ourselves on the quality and affordability of our products and our service to our customers. If, at any time, you are unhappy with any of our products or service, please call, write, or email.

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Phone: 941-349-1000 | Fax: 941-349-2766

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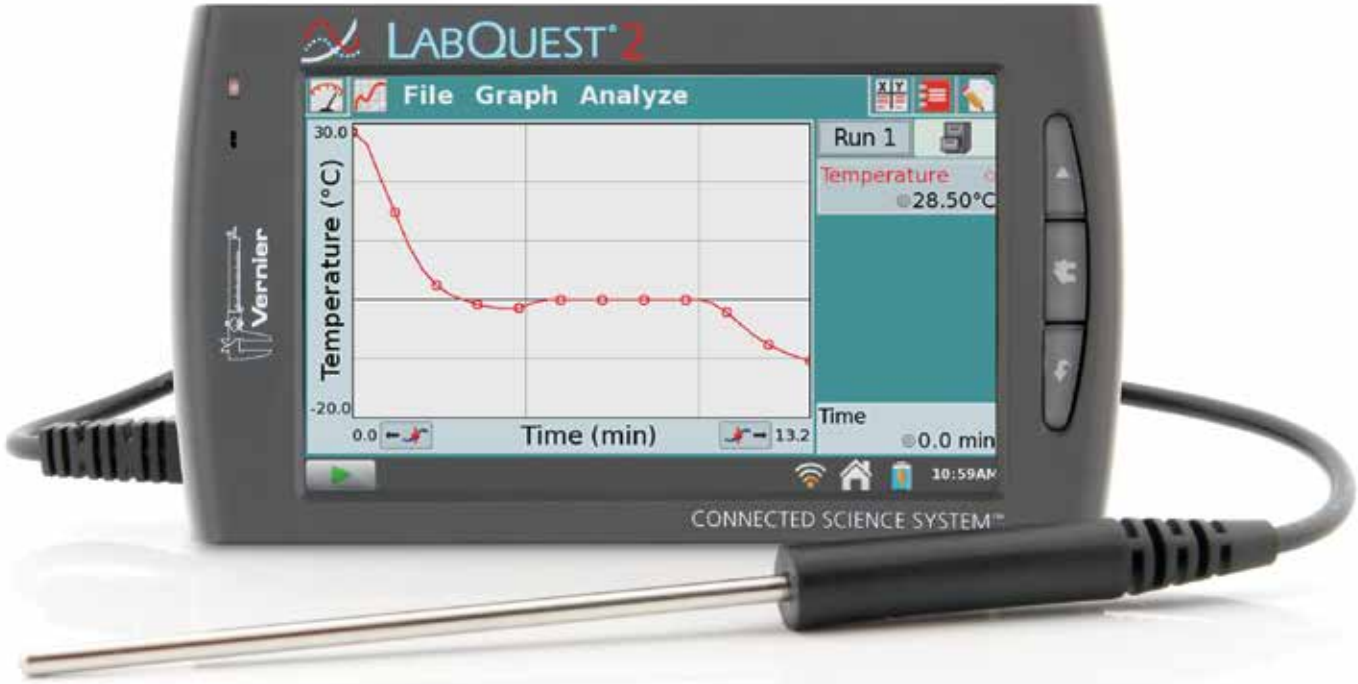

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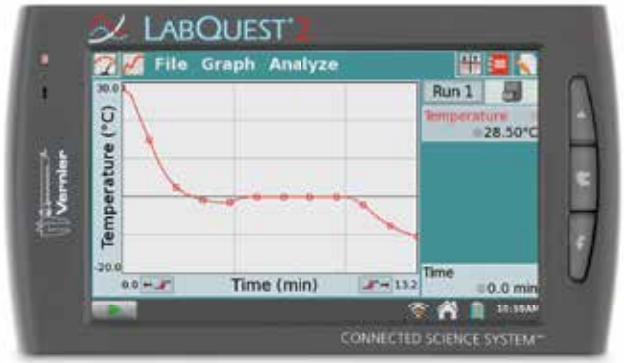

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